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POWER

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Per Cent of Rating

AT THE previous international industrial exposition at Philadelphia, that of 1876, when the contest was between the products of brains and ingenuity, a committee composed of the foremost steam engineers of the country conducted a series of boiler tests.

They had to have some unit by which to rate their boilers, so they took the amount of steam that would produce a horsepower-hour, more or less, in the better non-condensing engines of the time, thirty pounds at seventy pounds pressure, and called the production of that amount of steam at that pressure from feed water of one hundred degrees F. a boiler horsepower.

Boiler manufacturers settled down to ten square feet of heating surface per horsepower, so that the evaporation was around three pounds per square foot per hour at rating more or less, according to the pressure of the steam and the feed-water temperature.

But pressures got away beyond seventy pounds, superheat came in, feed-water temperatures were increased, forced draft, mechanical stokers and pulverized coal increased rates of combustion enormously, and we got into the silly habit of saying that a boiler was run at such a "per cent of rating."

If a 5,000 square foot boiler, rating at 500 horsepower, produces 1,500 horsepower, it is running at 300 per cent of rating.

This means that it is producing the equivalent of nine pounds of seventy-pound steam from one hundred degrees feed water instead of three pounds.

And for purposes of ordinary conversation the statement of the evaporation per square foot of heating surface would be a more direct and sensible index of the performance than the per cent of rating.

More precise statements, taking into account differences of pressure, superheat and feed-water temperature, could be made in units of evaporation of 1,000 B.t.u.'s each.

And this would come about more quickly if the "unit of evaporation" had a name as the units of length and volume and money have names.

The A.S.M.E. Test Codes define heating, or evaporating, surface, but water walls and extended surfaces are complicating that once simple matter. Something more is needed.

F. R. Low

Saving $28,000 Annually in Paper Mill Coal Cost

By J. G. BERGER
Consulting Engineer, Newark, New Jersey

INCREASING costs for raw materials and labor and lower prices for finished paper due to severe competition, made it imperative, about three years ago, for McEwan Brothers Company to reduce the coal used per ton of paperboard produced. This company, which operates a mill of 150 tons per 24 hours capacity at Whippany, N. J., therefore called in the writer, as consultant, to assist in accomplishing the needed saving.

The power plant at this mill has four Heine water-tube boilers of 6,106 sq.ft. of heating surface each. Other important equipment, as installed prior to the summer of 1925, when changes were begun, included: Three boiler feed pumps, one a spare; coal crusher and conveyor; draft regulators, feed-water regulators; one turbine-driven and two motor-driven forced-draft fans; and a closed feed-water heater.

Before endeavoring to improve the boiler operation, an efficiency test was made. Conditions made it necessary, during this test, to vary from standard practice by metering the feed water with a flow meter installed in the feed line. Just before the test this meter was calibrated and found to be accurate within one per cent. The coal was measured by counters placed on the stoker drives, and calibrations made at the beginning and end of the test were used in deriving the multiplier for the stroke counters, resulting in reasonable accuracy. Otherwise the test was conducted in the usual manner.

This test, of 48 hours' duration, was conducted from 3 p.m., July 28, 1925, to 3 p.m., July 30, 1925. The boilers had all been cleaned just before the test and were in good condition. Blowdown losses were accounted for by actual measurement, and leakage losses in the blowoff line were observed.

The coal used was a mixture of two-thirds Eureka and one-third Frances bituminous coal obtained from the mines of the Bertha Consumers Company. The Frances coal was lumpy and hard while the Eureka coal was finer and crushed more readily. Both were run-of-mine and

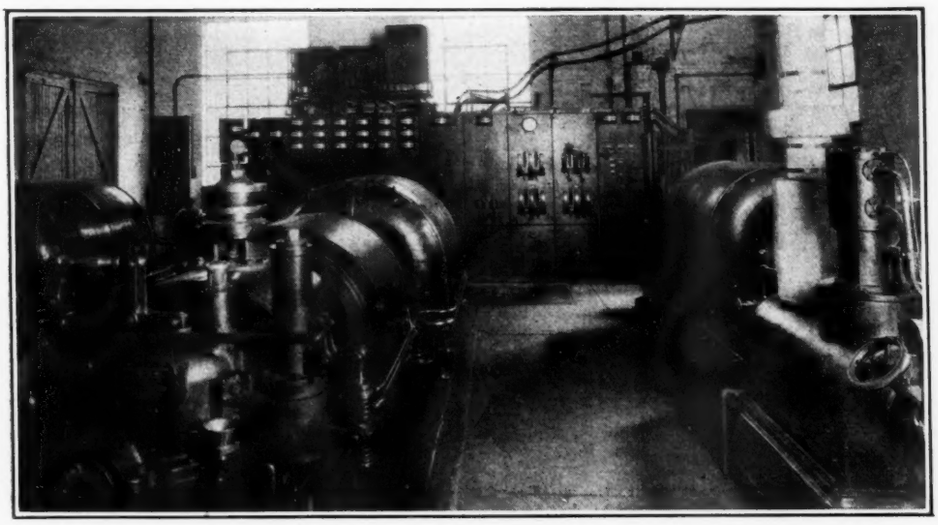


Fig. 1—Turbine room of McEwan Brothers Company paperboard mill, Whippany, N. J.

were crushed before being fed to the stoker hoppers.

Results of this test showed an equivalent evaporation from and at 212 deg. F. per lb. of combustible, of 8.94 lb.; and an efficiency, based on combustible, of 61.07 per cent. The per cent of rated capacity developed was 94.1.

The conclusion reached from the test was that, although reasonably good results were being produced, there was room for considerable improvement.

The setting, upon being candled, showed leaks. These were stopped with Johns-Manville "Airtite." Leaks were discovered in the breeching, in the seams and where it joined the boilers and stack. The seams were closed with "Smooth-on," the joints with asbestos cement.

It was found that the fires were kept well clear of the rear end when operating, the bridge walls had been omitted and there were no doors on the ashpits. This resulted in large quantities of cold air entering the ashpits, passing up through the spaces not covered with the fire and continuing on up through the boilers. To overcome this difficulty bridge walls were installed in each boiler, doors placed on the ashpits and kept closed except when cleaning, and the fires kept back against the bridge walls. This resulted in the two bottom rows of tubes below the first horizontal baffles becoming more effective, for the hot gases, in addition to the radiant heat, had an effect upon them, since these gases had to rise and go over the bridge wall. By calculation and adjustment under 200 per cent load operating conditions, all areas from the fires to the breeching were adjusted to suit the temperature of the cooling gases on their way to the chimney.

While this improvement was being made, it was found that, as a matter of maintenance, considerable of the old firebrick needed replacement. This replacement was made with a No. 33 cone firebrick from Ashland, Ky., and a high-temperature cement. Also new beams, with post support, were placed under the location of the bridge wall, where the old steel, owing to exposure to the heat, was considerably warped. Two rows of vented Bernitz carborundum blocks and one row of Bernitz blank carborundum blocks were installed under the bridge wall and in line with the fire, all air-cooled by connection to the forced-draft air duct. This was done because the carborundum blocks had a longer life under high heat, in addition to being air-cooled. Eventually, it is expected to place these blocks around the two sides, but not until the question of buying new stokers or keeping the old ones has been decided. It was expected that these blocks, by admitting air over the fire at the rear, would help the combustion. Carborundum also keeps the effective grate area at a maxi-

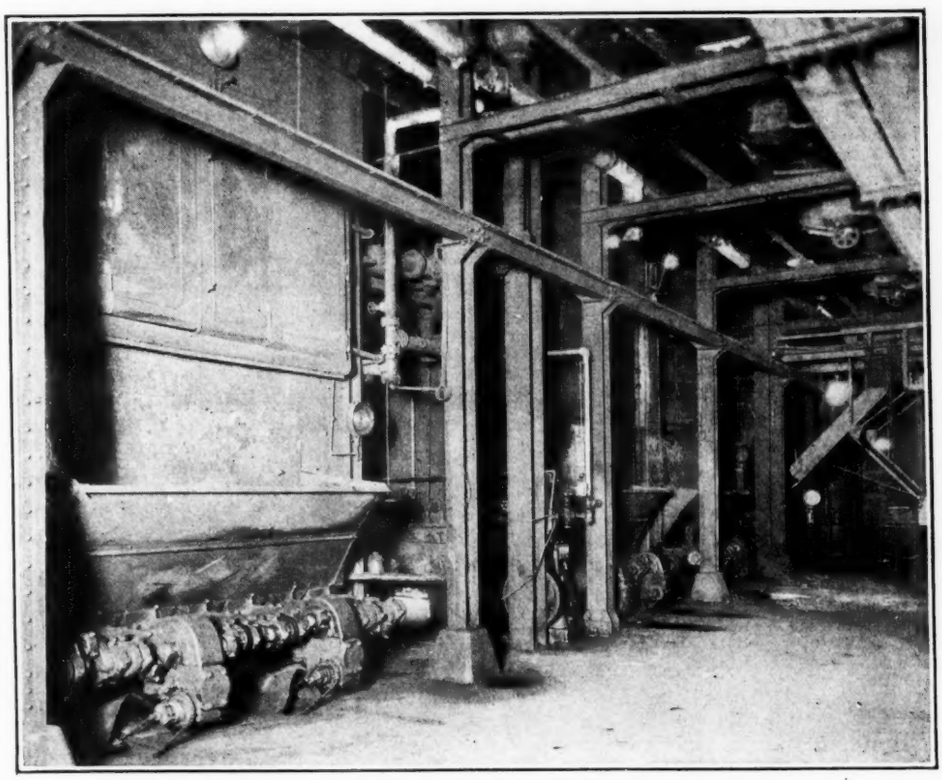


Fig. 2—Interior of boiler room, showing stokers and coal handling

mum, for clinker will not adhere to walls made of this material.

To prevent leaks in the blowoffs, two "Everlasting Crosby" blowoff valves and two asbestos plug cocks were installed at each boiler. The cocks replaced other similar cocks that were worn out, and the quick-opening valves replaced leaky rotary valves, which it did not seem possible to keep tight.

The rear doors, through which much air leaked, were bricked shut and opened only once in two weeks when the rear was cleaned out. The side doors had new linings placed in them as a matter of maintenance.

A new door was cut in the power house wall, with a ramp leading to it, so that soot and ash removed from the rear of the boilers need not be wheeled through the turbine room. The jet ash conveyor, which had never been used, was put in operation. The ashpit entrance, which at times had been extremely hot and full of gases when the fires were being cleaned, was properly vented. These changes lessened the labor required and made the work safer and more pleasant.

When the boilers were next cleaned, the drums were freed of scale, thoroughly cleaned, and coated with graphite paint rubbed in with a wire brush.

The method for feeding coal to the stoker hoppers was changed. The old way had been to pull a chute back and forth manually. This was replaced with a Richardson coal conveyor and scale and the stoker hoppers increased in size, all as shown in Fig. 2. As the chutes were entirely worn out, about half of the cost of this change was chargeable to maintenance.

Other changes included putting the draft regulators in first-class condition, repairing stoker fronts and grates in three of the boilers, and installing coke breakers in the grates. Special dump plates, cast so as to close better the opening between the rear of the grates and the bridge wall, were also installed. Other minor changes, such as better illumination, one new boiler tool and an auxiliary steam engine for the stoker drives, were made. And finally, better operating methods were put in force.

Results from Improved Plant

After the first test was completed, nearly a year was occupied in making the changes noted. Then, on July 13 and 14, 1926, a 24-hour test was conducted, in accordance with the A.S.M.E. Code, except that the water was metered, as before; although this time the coal was all weighed.

At the start and finish, fires were clean, the coal in the stoker hoppers level, and at both periods the fires were as nearly the same as possible and the water level the same. The boilers had all been down and cleaned within the previous three months. Ashpits were cleaned out at the start of the test, but at the conclusion of the test all ashes were weighed from the last cleaning of the fires. Thus the actual ashes made for the 24 hours of the test were weighed.

The coal used in this test was slack bituminous from the Consol, W. Va., mines of the Consolidation Coal Company. This coal had a heat content of 14,796 B.t.u. per lb. of combustible, compared to the 14,224.75 B.t.u. per lb. of combustible of the coal used in the first test.

Results of this test showed an equivalent evaporation from and at 212 deg. F. per lb. of combustible of 12.20 lb.; and an efficiency, based on combustible, of 80.1 per cent. The per cent of rated capacity developed was 113.7.

In the first test the cost of coal for evaporating 1,000 lb. of water from and at 212 deg. F. was $0.319. In the second test the corresponding coal cost was $0.221.

Based on a weekly average of 700 tons of paperboard produced, and taking into account that in 1925 the coal was of 13,000 B.t.u. heat value and, in 1926, of 13,823 B.t.u., that the 1925 cost of coal was $5.08 per ton against $4.625 in 1926, and that the ratio of steam used per ton of board, 1925 compared to 1926, was 1.00 to 1.11, the coal saving was calculated. It should be noted that, had the same drier efficiency been maintained in 1926 as in 1925, the saving would have been greater.

The actual decrease made in the cost of coal per ton of paperboard produced was $0.821. In a year this would make a saving of $29,884. Had the driers remained as efficient, the saving would have been $33,000 per year. Taking drier efficiency, heat content of coal and cost of coal per ton into account, the theoretical saving became $28,200 per year.

The total cost of all the changes in the plant to effect this saving, including the engineering fees, was $20,448.91. In conference with the owners these expenditures were apportioned between maintenance and improvements, $11,000 being charged to improvements, including the proportional amount of the engineering fee. Hence, by investing $11,000, a saving of $28,000 a year was made, which is 255 per cent of the investment and, capitalized at 6 per cent, has a borrowing value of $466,666. Though savings are still possible in this paper mill, the results obtained indicate how a small investment in power plant modernization and repair will bring large financial returns and make the plant, at the same time, a safer and more pleasant place to work.

Influence of Inherent Moisture on Combustion of Coal Under Boilers

THE use of preheated air in the mill to fry the coal has in its favor lower first cost in smaller building requirements, compact arrangement and simple operation. In the case of unit systems it has the added advantage that there is no vent pipe necessary, as all dust is delivered direct with the primary air to the furnace.

It has been objected that the moisture in the coal is also delivered to the furnace. Theoretically, this should result in a slightly increased flue gas loss from superheating this vapor. However, some recently published tests in England indicate that this moisture may be a desirable addition in the furnace as it appears to have a catalytic effect in increasing the rate of the combustion reaction of the hydrogen and carbon monoxide of the furnace gases.—*Combustion.*

THE FORMATION OF OIL VAPOR in steam-engine crankcases, air compressors and other power-plant machinery has been responsible for numerous explosions. Oil vapor, when mixed with a certain proportion of air, forms a highly explosive mixture, which, if ignited, may cause much damage. Engine explosions due to oil vapor mostly occur in connection with high-speed vertical engines with inclosed crankcases and splash lubrication.

Some Experiences with the High-Pressure Boilers at Edgar Station

IN THE issue of June 15, 1926, *Power* was privileged to record the first six months' operating experience of the initial 1,200-lb. unit at Edgar Station of the Edison Electric Illuminating Company of Boston, particularly with reference to the condition of the turbine blading after this period of service.

In the same spirit of helpfulness to the profession through frank discussion of operating problems, I. E. Moultrop, chief engineer of the company, with the cooperation of the equipment manufacturers, has released to *Power* readers an account of some experiences with the two boilers comprising the second high-pressure unit. These went into service several months ago. Each is designed to generate 270,000 lb. of steam per hour and is fired by a 16-retort 45-tuyere underfeed stoker.

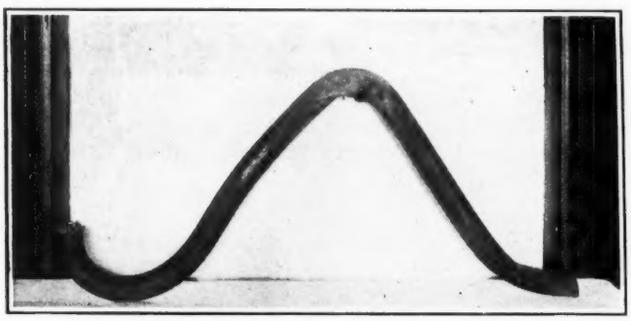


Fig. 1—Ruptured superheater tube showing effect of reaction produced by jet of steam

Briefly, the troubles encountered to date have consisted chiefly of water-wall tube failures, superheater burnouts and some difficulty in operating the stokers with highly preheated air.

The tube failures are significant in having demonstrated that there is no greater danger to personnel or property as concerns this kind of failure when operating at 1,000 to 1,200 lb. than with low-pressure steam. The steam from the superheater tube ruptures was carried away by the induced-draft apparatus and in one instance the boiler was kept on the line for more than an hour until another unit could be placed in service. In the case of one of the water-wall failures the jet of water swept the coal off the stoker for a considerable distance and quenched the fire.

The superheater tube failures, of which there were five, three in one boiler and two in the other, occurred mostly in the second tube of the second pass. These superheaters were designed for a minimum pressure drop, and it became apparent that circulation was faulty at this particular location; in other words, there was a dead spot. This is being rectified by shifting the baffles in the superheater header. The superheaters are designed for a temperature of 725 deg. F. An idea of the reactive force of the issuing steam jet may be had by reference to Fig. 1.

The water walls on the side and rear are protected by refractory-faced block down to about two feet above the fuel line, below which the tubes are protected by bare steel blocks.

Although there were only two actual ruptures of water-wall tubes, 40 were found to have been overheated so as to necessitate replacing. These all occurred in the lower section of the back wall protected by bare steel

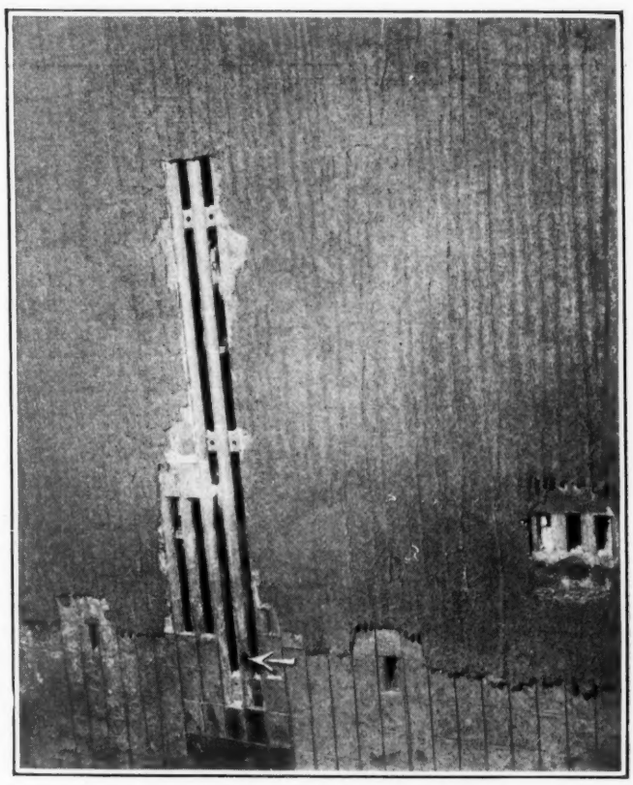


Fig. 2—The first rupture occurred on the bare portion of the tube at an inspection door; see arrow

blocks and were in the one boiler No. 5. This boiler had been on and off the line many times during a period of six weeks to permit changes in the air supply to the stokers, to renew superheater tubes, etc. On the other hand, boiler No. 6 had been running almost continuously during this period under steady load without preheated air. It was significant that the water-wall failures were coincident with bringing the boiler up to normal pressure and load after it had been temporarily off the line.

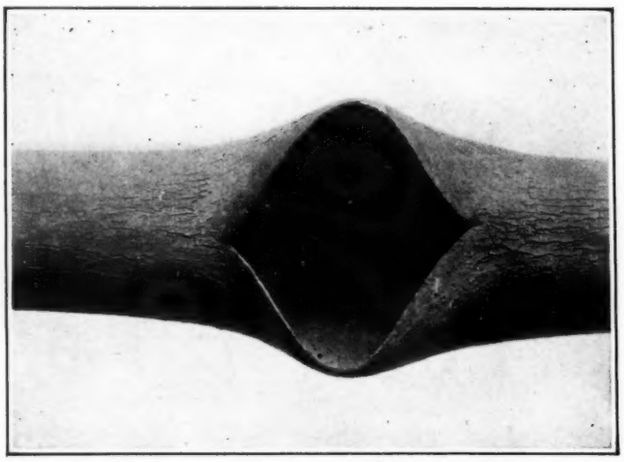


Fig. 3—Close-up of ruptured superheater tube; second tube in second pass

The first of these ruptures occurred on Dec. 12, the failure taking place on the bare portion of the tube at an inspection door. This is indicated in Fig. 2, showing the ruptured tube with adjacent blocks removed. Tubes at some of the other inspection doors showed signs of burning. A subsequent examination of the interior of these and the other tubes removed showed no signs of scale or corrosion.

At the time of the failure the steam pressure was about 1,000 lb., the boiler had been on the line about half an hour and was operating then at about 50,000 lb. of steam per hour. It had been brought up to pressure earlier, but a gasket blowing on one of the connecting lines had caused it to be held back. The stoker at the time of this burnout was carrying a higher fuel bed at the clinker grinders than is usual, and coal was being burned at a very high rate at this point; hence there was an intense heat in the region of the rear wall with occasional flame impingement. When the boiler is operating at full pressure, the circulation is adequate to carry this heat away, but with an intense fire on the rear of the stoker and low pressure the circulation was inadequate and localized overheating occurred.

A contributing factor in this case was undoubtedly the bare steel blocks surrounding the inspection doors. In some other installations the door opening is surrounded with refractory-faced blocks which shadow these tubes. Such refractory-faced blocks often accumulate a slag screen which has to be broken through when making an observation, and it was to avoid this that the bare blocks were employed. As a result of this experience the refractory-faced blocks will be replaced on the upper inspection doors and the lower one will be closed. Also, the refractory-faced blocks will be carried about two rows lower on the rear wall.

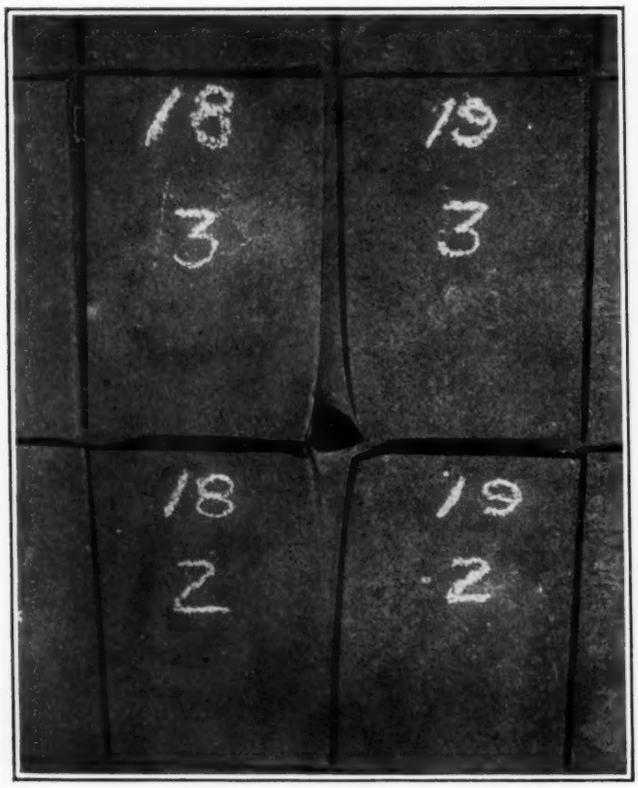


Fig. 4—Rupture in water-wall tube
Note how corners of blocks are turned back.

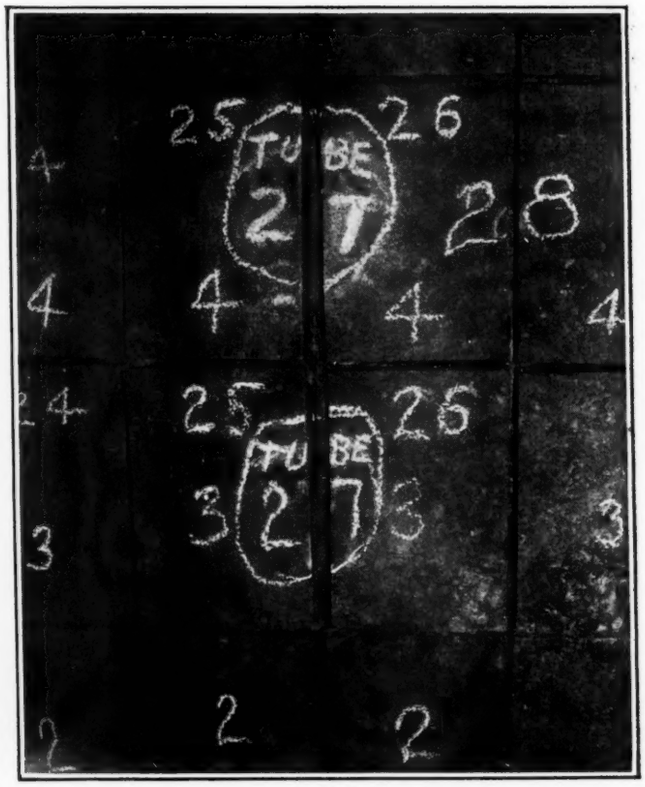


Fig. 5—Shows bulge in back-wall tube
The tubes were detected and removed.

The second water-wall failure occurred on Jan. 7 while No. 5 boiler was operating at 1,200 lb., but following a period of some hours off the line occasioned by superheater tube trouble. During this interval the fire had been quenched with a hose and there was, in consequence, a full bed of coke on the stoker, especially on the rear section. This had dried, and in starting up again without compartment draft control, an intense fire soon built up at the rear of the stoker while the pressure was still low, generating more steam than the circulating system was designed to take care of.

The tube ruptured at the junction of the four steel blocks well below the normal fuel-bed level (See Fig. 4) and the corners of the blocks were bent back by the bulging of the tube. Fig. 5 shows one of several other sections where distortion of the tubes through overheating had turned the edges of the blocks out. In all there were 40 tubes that had to be replaced. These burned sections lay in a zone about two feet high and seventeen feet wide. Steps are now being taken to amplify the circulation system.

Cost of Compressed Air

By Fred Emmarr

COMPRESSED air, judging by its abuse by many operators, seems to be a cheap fluid in some plants. Valves continue to leak air, as do poor connections, broken hose, etc., while large amounts are used in cleaning clothes and sweeping floors.

In reality compressed air is expensive, much more costly than the other plant fluids, steam, water or electric power. It takes steam or electric power to compress air, and the power put into the compressors is certainly greater than that obtainable by the re-expansion of the compressed air. Besides, there are many other charges that should be added to the mere production costs.

In determining the cost of compressed air, all these items must be considered. Many smaller plants neglect these extra costs. These include the following: Steam or power to run the compressors; cooling water for jackets, etc.; water and power for condensers, if driven by a condensing engine; cylinder and compressor oil; waste, rags and cleaning materials; material and labor of repairs, including all piping and valve maintenance; operating labor and supervision; depreciation and interest on investment; overhead charges, taxes, etc.; and other charges applicable in any way to the air supply.

Compressed air should be charged to all departments using it. If there are several compressors isolated at various parts of the plant, their costs and production should be lumped and carried in one total. If one department uses the entire air output of a unit located therein, the charges against this compressor may be made directly to the department.

In allocating the cost of this air, each department should be charged with its pro rata share, depending upon its usage and consumption. Having all air costs for the various units lumped renders this distribution more simple, in terms of per cent of this total.

To distribute the air costs correctly to the different users is well nigh impossible, as the consumption of each is a difficult figure to obtain. To meter the air used by each piece of equipment is a physical impossibility.

What Do You Know?

By L. H. Morrison

The answers are on page 482

Ques. 1—What is the diameter of a circle whose area in square inches equals numerically its circumference in linear inches?

Ques. 2—Which type of steam pump uses less steam for a given duty, simplex or duplex?

Ques. 3—Have tandem Diesels ever been built?

Ques. 4—Is there any difference between the boiling point of a liquid and the condensing point of a vapor?

Ques. 5 Where would you look for the fusible plug on a vertical fire-tube boiler?

Ques. 6—How is water going through a cooling tower cooled?

Ques. 7—Should you shut down a boiler without flooding the superheater tubes with water?

Ques. 8—What causes water hammer, or pounding in the piping of a steam heating system?

Ques. 9—A load of 180 kw. which has a power factor of 0.60, is being supplied from an alternating-current system. If it were desired to increase the power factor to 0.85, what size static condenser would be required and what would the kva. load be at the new power factor?

Ques. 10—Which Corliss engine will show the higher m.e.p. with cutoff occurring at the same point in the piston stroke, an engine with 4 per cent or an engine with 10 per cent clearance?

When the Rate of Fuel Burning is increased beyond a certain point in a standard boiler with brick-lined furnaces, the high temperature and erosion tend to cause the brickwork to fail quickly. This can be prevented in the case of stoker furnaces, within the limits of economical operation, if there is an opportunity to obtain suitable proportioning of the boiler, furnace and grate and proper inclination and construction of furnace walls. To overcome side-wall trouble, particularly with pulverized fuel, additional boiler tubes have been introduced around the furnace as a protection.

Fig. 1—Transporting a steam turbine in Mukden

Snap Shots From the

Erecting Engineer's Camera Taken in Many Lands

By N. L. REA
Construction Engineer, General Electric Company

MOST of us are so used to paved roads, trucks, tractors, railroads and big ships, that the difficulties of transportation are often overlooked if not forgotten altogether. The pictures in this article, taken from the reports of erecting engineers, illustrate better than many words the problems confronting these engineers in different parts of the world. They also show how many solutions are possible to the problem of moving an object from one place to another and how all the answers are right when local conditions are taken into account. Furthermore, they show the development of transportation from man power to the latest equipment of special trailers drawn by trucks and tractors.

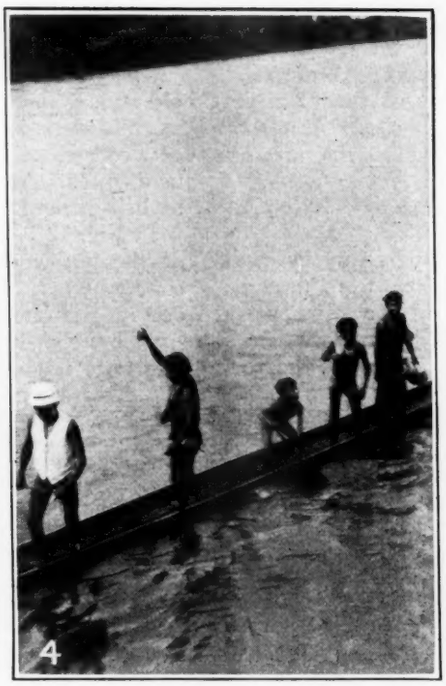
Fig. 3 shows porters in the interior of Colombia carrying boxes of equipment from the landing to the storehouse. One of the canoes used for some of this work is shown in Fig. 4, but this picture was taken on "steamboat day," a gala occasion when everybody dresses up with all of his best glad rags. Note the Beau Brummel in the front of the boat, on the left, dressed in a white vest and a boudoir cap. In Fig. 5 we have a part of a line of sixty Spanish peons carrying into the hills a kilometer of transmission copper, a weight of about a ton. This is all one piece of wire; the connection between the coils can be seen on the left of the carriers.

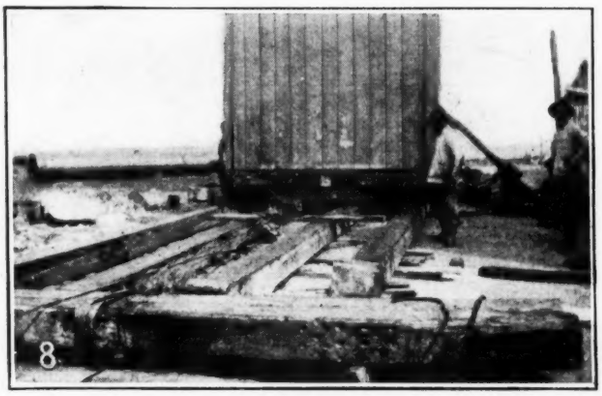
Fig. 2—Part of a generator stator being transported in Nepal, India

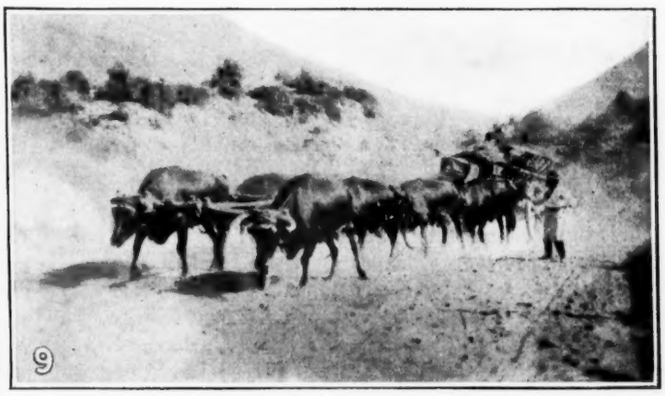
Fig. 2 shows the next step in transportation, combining a number of men on a single piece. This picture was taken in Nepal, India. The piece is placed on two skids, and the carrying sticks are attached to these skids. The men are graded for height and the ropes tied to adjust the load to the carriers. Labor is cheap and time is no object.

One of our erecting engineers in Afghanistan ordered two steel I-beams from England. They came up the Persian Gulf, and a contract was let for the long cross-country haul to Kabul and to the power plant.

After months of waiting a searching party finally found the beams across a native well several miles off the trail. The head man was accused of stealing the beams, "But Master, I am the contractor, I got the beams this far and it was time to plant the rice. If we do not have rice, we starve! When the rice was planted, there was not time before it gets ripe. Soon it will be ripe and harvested, and then I bring the beams." Conditions met with in water







Figs. 3 to 9—Transportation scenes from countries where labor is cheap and time is no object and no one worries except those who have to get something done

Fig. 3—Porters in the interior of Colombia, South America, carrying boxes of equipment. Fig. 4—One of the canoes used for transportation; this happens to be a gala day when everybody is dressed up. Fig. 5—Part of a line of 60 Spanish peons carrying a kilometer of transmission line into the hills; this is all one piece and weighs nearly a ton. Figs. 6 and 7—One wheel and two wheel carts used in China for transportation purposes. Fig. 8—A Chinese rigger's method of moving a heavy machine over soft ground. Fig. 9—Ox-team transportation in Chile. The going is slow but they eventually reach their destination.

transportation are sometimes difficult. Equipment boxed to fit in a canoe may be manhandled for from four to six weeks before reaching its destination. All the markings are scuffed off the boxes, many of them are part full of water, small transformers may be used as anchors and other incidental happenings add to the erector's joys.

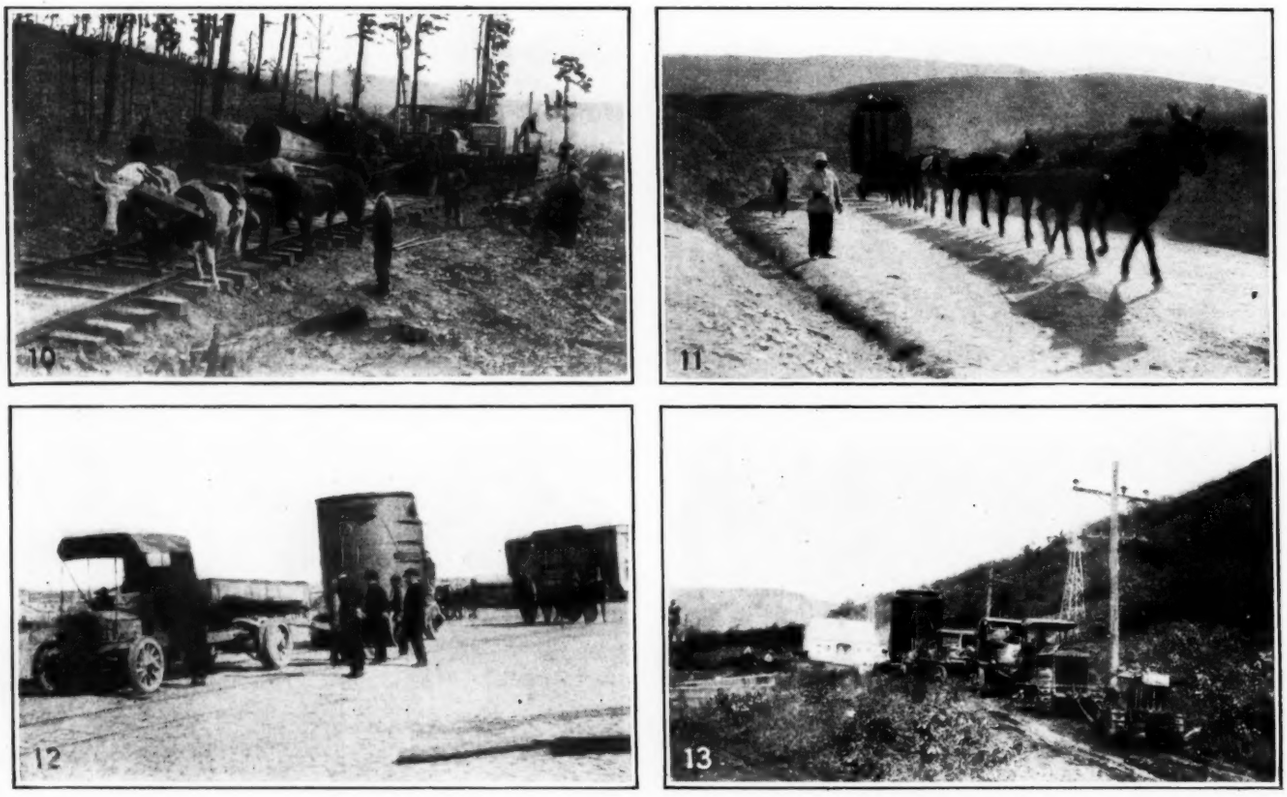
Mules Instead of Oxen

In one case the machines traveled part way by canoe and then were packed on oxen. Oxen were used because they were better than mules in the swamps and could be used for food when their backs got sore.

The next stage in transportation's history is the pack animal, our friend the "mountain canary." From pack animals man went to wheels moved by man power, and in Figs. 6 and 7 we have one-wheel and two-wheel outfits adapted to present-day construction in China. In some ways the Chinaman isn't so slow. We have always been told that "You can't lift yourself by the bootstrap or the seat of your pants," but in Fig. 8 a Chinese rigger is nearly doing it. He is moving heavy pieces across soft ground by pulling against the ends of the timbers on which the piece is rolled. Another piece is used as a "deadman" to anchor a hand winch, and half a dozen husky coolies furnish power for the winch to wind in the tag rope.

Ox teams are used the world over, and Fig. 9 shows a freight outfit in Chile. We hear our grandsires tell of wood-burning locomotives, but Fig. 10 shows a six-cylinder "hay burner" moving a flat car loaded with machinery. In Fig. 11 the Spanish way of using a "straight-eight" outfit is pictured, while Fig. 1 shows how old style Chinese equipment was adapted for handling a steam turbine in Mukden. These carts are made entirely of wood with live axles, and every horse or mule has his own traces. As the axles run without lubricant, no horn or bell is necessary to announce its coming.

In Fig. 12 is a Uruguayan scene. On the right is one of the big wheeled pampas carts built to travel open country where roads are only a name and ruts are hip deep. The latest "gasoline era" is shown in No. 13, a special rubber-tired trailer drawn by trucks and tractors. The little fellow in front swaps to the rear end to hold back on the down grades or to the side where there is danger of skidding. The little fellow may be small in dimensions, but is big in usefulness.



Figs. 10 to 13—From oxen to motor-truck transportation

Fig. 10—A six-ox team used to move a loaded freight car loaded with power machinery. Fig. 11—Tandem-eight-mule team transporting a large transformer in Spanish style. Fig. 12—A scene in Uraguay, not so unlike the one in Fig. 13, taken in our own country, where two trucks and two tractors are used to move a large transformer on a trailer.

Projected Area of a Rivet—The projected area of any object is the area of outline of the projection such as shown by projections or views of ordinary mechanical drawings of objects, which are known as "orthographic" projections. An orthographic projection giving the side view of a piece of shafting would show the length and diameter. The figure would be a rectangle and the projected area would be the area of the rectangle, that is, the length multiplied by the diameter. The projected area of that part of a rivet which takes the bearing of a plate is the diameter of the rivet multiplied by the thickness of the plate.

Developing Power

From a Factory Waste

Mixed-Pressure Turbine Uses Exhaust of Steam Hammers in the Henry Vogt Machine Company's Plant—Reduction in Power Costs Is Enough to Repay Investment in a Short Time

USING exhaust steam from power generating units in processes and for other factory purposes is a common practice. But how often we hear of a situation where waste steam from the factory is brought back to the power plant to be put through steam turbines!

This plan of using a waste from the shop in power generating equipment has been functioning long enough at the shops of the Henry Vogt Machine Company, Louisville, Ky., to demonstrate both its feasibility and its economy. While it is admittedly a method not applicable in every mill and shop, there are many plants where a similar installation would be worth while.

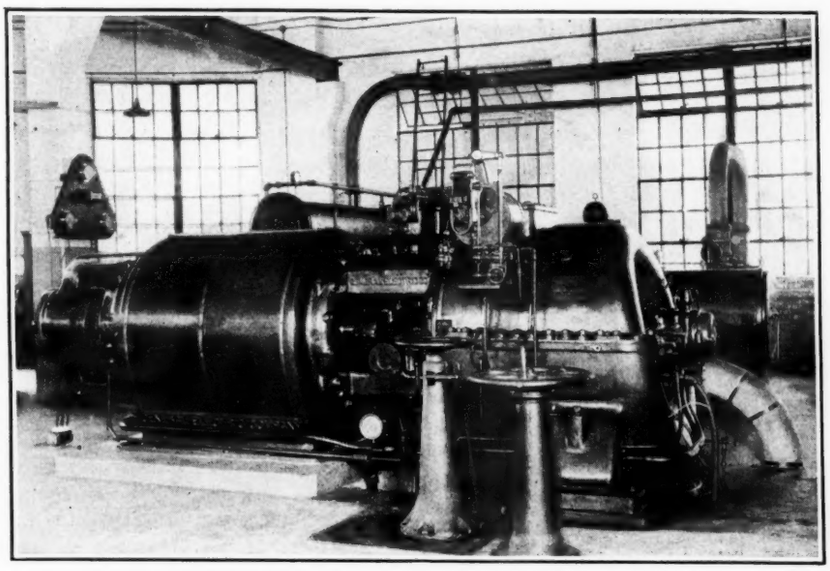


Fig. 1—The 750-kw. G. E. mixed-pressure turbine

This company manufactures boilers, oil-refinery tank work, refrigerating equipment and drop-forged valves and fittings. In all this work extensive use is made of compressed air. To supply this air, three non-condensing steam-driven compressors were used formerly, taking steam at 125 lb. gage. Power needed by the many direct-current motors was generated by three non-condensing Corliss engines driving direct-current generators. The compressors and engines were in the shop buildings, and the steam reached them through underground pipe lines from two 5,000-sq.ft. Vogt water-tube boilers in the boiler house.

In the drop-forging shops a number of steam-operated hammers forged or pressed the fittings out of solid steel billets.

Although the boilers were built for 175 lb. pressure, the engines were designed for but 125 lb. pressure; consequently, the boilers were operated at the lower pressure. These boilers were equipped with Illinois chain grates with natural draft.

Under the conditions existing, say in 1921, the compressors delivered about 1,500 cu.ft. of air per minute during the working hours. The electrical consumption was at an hourly rate of approximately 450 kilowatts. On an average 7,000,000 lb. of steam were generated each month and the non-condensing operation of the compressors and hammers was, of course, very inefficient from a thermal viewpoint. Even in the winter months the lack of balance between the heating demand and the exhaust-steam supply occasioned an immense loss; furthermore the generation of power with non-condensing engines was expensive, especially as the units were heavily loaded.

Taking November, 1921, as a representative month, the coal, steam and air consumption were:

	Total Used	Cost
Coal ($2.28 per ton), tons	574	$1,308.72
Steam generated, lb.	7,298,845	.....
Evaporation, lb. water per lb. coal	6.3	.....
Electricity generated, kw.-hr.	51,430	1,370.32
Electricity purchased, kw.-hr.	1,730	69.20
Air, cu.ft.	6,500,849	601.51

Increased shop production called for more air, more steam for the hammers and more electrical energy for the motors. As a first step, a 5,400-sq.ft. and a 5,600-sq.ft. boiler were installed with Riley underfeed stokers. Foster superheaters to give 100 deg. superheat were placed in the first passes of all four boilers.

The engines were not capable of developing enough power to meet the new demand and an additional generating unit was imperative.

An engineering study of the situation led to the determination to make some use of the exhaust steam from the drop hammers and from the air compressors. The

amount of energy in the large volumes of this steam was enormous in view of the amount of live steam going to these machines. But a straight low-pressure turbine taking steam at two or three pounds initial pressure, while using the waste product would not develop sufficient power.

A second factor entering into the problem was the steam-heating requirements in winter. While some of the newer buildings used live steam heating elements, the older shops were piped for low pressure. The exhaust from the hammers and compressors during periods when all the shops were not running full force would not be sufficient to meet the low-pressure heating requirements. At the same time it was highly undesirable to pass high-pressure steam through a reducing valve to the coils if it were at all possible to develop first all possible power in making the pressure drop.

After examination of all the phases of the problem it was determined to abandon the existing steam engines and to install a 750-kw. mixed-pressure turbine arranged to be bled as well. This turbine drives a 750-kw. 480-volt three-phase 60-cycle alternator, which has a direct-connected exciter.

This machine, together with other new equipment, was installed in a new engine room adjoining the boiler room. The exhaust from the compressors and hammers at 3 lb. gage is admitted to the second stage of the turbine, while live steam at 150 lb. gage and 100 deg. F. superheat is admitted to the first stage. The amount of live steam used is under control of the governor, which passes just enough to meet the deficiency of the 3-lb. steam under the existing turbine load.

In addition the heating line is connected to the 30-lb. main, and if the pressure in this drops owing to the heating requirements, steam is automatically bled from the turbine at the second stage.

An Elliott jet condenser was installed in the basement under the turbine. The condensing water is pumped by

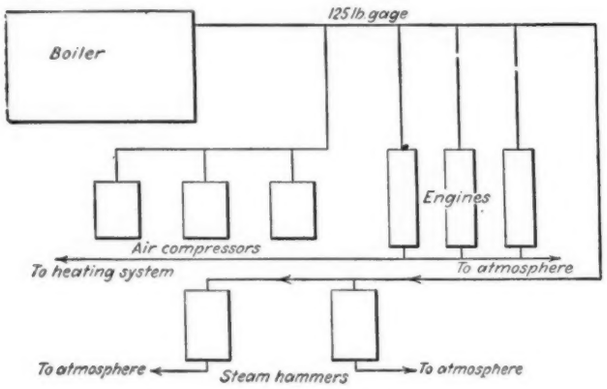


Fig. 2—Diagram of old power layout

the centrifugal pump of the condenser through spray nozzles on the roof, and the water returns to the jet condenser under a gravity head. Makeup is obtained from the city mains, as is also the boiler feed. This latter is put through a zeolite treatment and is raised in temperature in the heater by the exhaust from the boiler feed pump.

One of the old compressors, a compound-steam and compound-air unit, size 15 and 29 by 25 and 16 by 20-in. stroke was moved to the new plant and a new Ingersoll-Rand unit having steam cylinders 18- and 34-in. bores and air cylinders 30- and 19-in. bores by 24-in. stroke was purchased.

Since the older motors were direct current, a 50- and a 240-kw. motor generator were installed to supply the direct current. The larger unit has a synchronous motor, which serves to raise the power factor of the system.

The switchboard has two generator panels and an

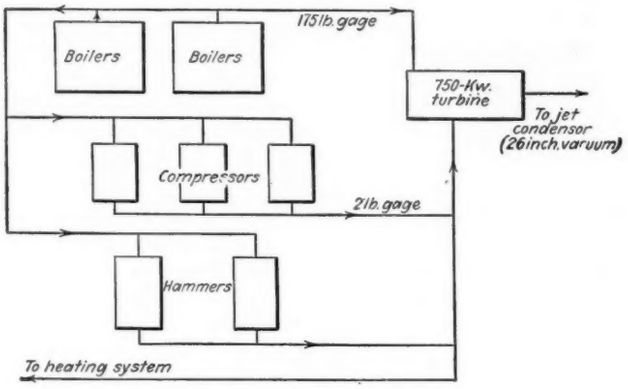


Fig. 3—Diagram of the new hook-up

exciter panel. There are also 13 alternating-current feeder and 7 direct-current feeder panels.

After the equipment had been in for some time, the power demand increased to a point where another unit was needed. This led to the installation of a 200-kw. generator direct connected to an Ames uniflow engine.

The results obtained from the arrangement have been highly satisfactory. Using November, 1926, as an example, the plant has the following record:

	Total	Cost
Coal, tons	1,334	$2,788.06
Steam generated, lb.	16,085,000	.....
Evaporation, lb. steam per lb. of coal	6	.....
Electricity generated, kw.-hr.	228,836	$2,027.00
Electrically purchased, kw.-hr.	7,200	144.00
Air, cu.ft.	15,147,000	834
Steam to forge shop, lb.	5,500,000	.....

It will be noted that in 1921 the generated electricity cost 2.47c. per kw.-hr. This includes all steam used, all labor, overhead and maintenance charges. In 1926 the cost per kilowatt-hour dropped to 0.89 cent. This figure also includes all charges. In arriving at the proper charge to make for the steam used by the turbine, the operating engineer took the position that since the steam from the compressors and hammers heretofore had been wasted, the turbine should not be charged with all the heat in this exhaust steam. The only legitimate charge would be for that part of the heat actually used in the turbine to develop power. Consequently, in making up the cost sheet, he assesses against the turbine the cost of generating the live steam going to the turbine. He then charges the turbine with the heat abstracted from the exhaust steam used and credits this to the hammers and compressors in the proper ratio. At the same time he charges these machines with all the live steam they receive.

It is interesting to note that the existence of the turbine reduces the cost of operating the compressors and hammers, by reason of the credit items mentioned.

The operation of the plant has been satisfying, although a few kinks had to be straightened. It was found that a good deal of fibrous packing came over from the hammers. This material soon choked up the

small screen filter on the turbine. To avoid this trouble a large screen filter was placed in the line from the hammer. When the hammers shut down, the pressure in the line to the turbine dropped. This caused the turbine to bleed back into this line, and as it was several hundred feet in length, the loss by condensation was large, but the larger loss was the steam that escaped through the drain lines at the hammers. To avoid this a clack check valve was placed in the 3-lb. line inside the engine room.

The costs given are accurate, for the plant is equipped with steam-flow meters, feed-water meters, recording pressure gages and thermometers. While the monthly load is not uniform through the year, the November records may be used to estimate the yearly saving. Under the old conditions of 2.47c. per kw.-hr., the cost of the generated power would have been $56,422; the new arrangement saves over $3,600 per month, or about $43,000 per year on electrical energy costs alone.

Liberating Surface in the Steam Boiler

By Benjamin J. Parker

GIVE us liberty or give us death was the battle cry back in the dawn of American history as well as in the history of the steam boiler, and in an early issue of *Power* of this year you read an article about the "Water Level in the Boiler," and in this discussion was a statement regarding the liberating surface necessary in a boiler and that we used a method in figuring it out.

It is true that it can be figured out. It is also true that it has been figured out.

And to make a long story short.

Since we have the water-tube boiler and now the modern water-tube boiler that is *all boiler*, even the furnace walls and part of the coal pile or oil tank. Since we have these boilers, we leave the liberating surface out without figuring it out. But the Editor asked me to write something giving a simple rule for figuring the liberating surface, so I am going to give you that simple rule we used in the plant conditions mentioned in our previous article (*Power*, April 26, 1927, p. 631).

In a simple little story.

Once upon a time they built boilers by the barrel and cut them off when they had to. And in ye goode olde days the more barrels the boiler had the better.

The boiler then had a barrel in the attic, a barrel in the front room and one or two barrels in the cellar. It really isn't so long ago that such boilers were in operation. I saw one yesterday in good condition yet. And in the middle drum they put more or less tubes if you insisted on tubes. Hence arose, no doubt, the quaint idea often amounting to a superstition, that the more water they had in the barrels the more room they must give the steam to get loose from the water.

So they used a very simple and natural law of physics together with a lot of assumptions. They figured on an engine taking 30 lb. of steam per horsepower-hour at 75 lb. gage, or 90 lb. absolute. At this pressure dry saturated steam, which they assumed they had, as a specific volume of 4.85 cu.ft. per lb., so that the steam used per hour would occupy 30x4.85 cu.ft. Next they assumed that the engine runs at 60 r.p.m., or 3,600 revolutions per hour. And then they hit upon the happy thought that the free space in the boiler should hold enough steam to feed the engine for 20 seconds. This makes it easy to figure the space required as $\frac{30 \times 4.85 \times 20}{3{,}600} = 0.81$ cu.ft. per horsepower of engine capacity. Or, if we call some of the numbers by different names, the answer comes out the same for one horsepower of nominal boiler rating according to the old traditional standards. This is all I know about figuring steam space or liberating surface, and it seems to be all anyone knows, for I've delved into volumes ancient and modern on the subject of the design of steam boilers, and each author uses approximately this factor, though some say where they got it and others don't.

The most recent book on this subject I've been able to see was written by a gentlemen from Australia, who frankly states that up to the date of his book (1926) little or no positive or practical data were to be had on this question, and in the design of steam space the factor used is generally from 0.6 to 0.8 cu.ft. per horsepower. But when you use this factor in considering the liberating surface for a locomotive traveling 60 miles an hour on a track, it is to smile.

Or a standard power station water-tube boiler at 200 per cent over rating—it is to laugh. And then the last word in boiler design with their water walls giving ratings that seem incredible.

It is time to put the old barrel boiler formulas away with a sigh, and it is generally agreed by modern builders of water tube boilers that the liberating surface required is only that of equal area to the upcomers into the steam drum. But I started this argument in the previous article, having in mind the barrel type boiler, and we do know from sorrowful experience that a water level in this type of boiler is easily attained where the water will not stay put.

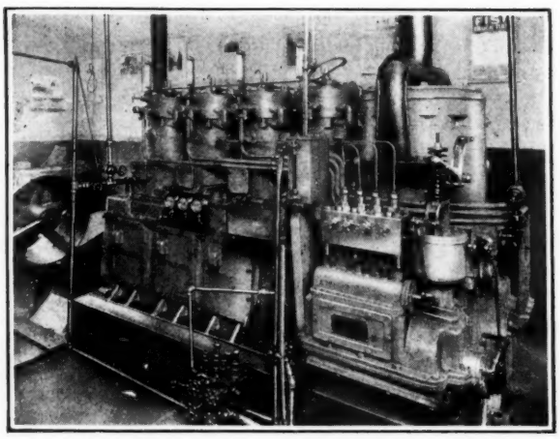
This was the real point of the previous article, where emphasis was intended. And the practical method detailed in that article, of actually finding out where the water stands in the shell at operating conditions and the maintenance of a level at a safe margin above the low level, will result in the more satisfactory and efficient generation of dry saturated steam. Personally, since studying the designs of the new water-wall furnace boilers, I don't believe in liberating surface or space any more, unless it is in the ratio of a spark gap, for these boilers have more upcomer tubes in their shells than anyone would dream of a few years back.

But that does not detract from the fact that we stopped our priming trouble by dropping our water level several inches in the old inclined-drum water-tube type. And the moral is if you can add more tubes or heating surface to the flames, DO IT.

A High-Pressure German Boiler has primary and secondary systems. Part of the primary system is a coil lying in the drum of the secondary system. Condensation of the primary steam in this coil generates the secondary steam from pure or impure water. This has been applied to a German locomotive.

INTERNAL COMBUSTION ENGINES

The New and the Old Methods of Babbitting Bearings



By A. B. NEWELL

Defects in Old-Style Babbitt Bearings—Necessity of Proper Oil Grooves—Advantages of Centrifugal Cast Bearings

THE criticism has often been made that engine bearings are still made after old designs. It is true that years of machinery improvement elapsed before any major change took place in the method of running bearings. The ladle and mandrel method prevailed so long that it appeared ready to withstand the test of ages, but the development of the oil engine made necessary a more satisfactory method and set manufacturers to thinking on the vitally important subject of how to make babbitt do its work without causing trouble. At the outset we must give the metallurgist credit for having worked many wonders in the development of highly satisfactory bearing metals.

It is not divulging a secret to state that bearings have been one of our oil-engine problems and that we have many times devised a method that would answer an immediate need, only to have new developments in the engine again throw us into a state of bewilderment. At one time it was difficult to find a metal that would not batter down and squeeze out of the bearings like lead, or so we thought. Pessimists assumed that Diesels carried too much bearing pressure as the result of the high working pressures and the necessary heavy inertia forces.

Bearing pressures were not too great. Lubricating oil manufacturers demonstrated that a film of oil could be maintained and still we had broken babbitt, not through faulty lubrication, poor metal or excessive pressures, we were told, but as the result of that elusive and undefined condition of shock.

At present we are making more rapid strides in the design and construction of oil-engine bearings than has ever occurred in the manufacture of any other sort of bearing. By flowing the metal in a spinning bearing shell many of our former difficulties have been overcome, but the mere act of spinning does not solve the problem entirely. It accomplishes just what we have been attempting to do by providing anchorage, tinning and peening, separately or collectively. More than that, it proves that we have passed some troublesome stages and it has taught us the value of bonding metals.

Many can remember when babbitt did not stick to the bearing shell. It was poured hot, molded to the shape of the anchorage and hammered down tight, after which it was bored to dimension, scraped to fit, carved here and there with oil passages, and it did its work. Then it was common practice to peen the babbitt, and it is still, because some mechanics thought that in this way it could be made to fit. Others declared that it made the running surface harder and more capable of withstanding wear, while a few thought that the texture of the metal was changed, so as to toughen it. Perhaps this was all true of the metal and the service then prevailing, but changes have occurred. In some instances peening seems of questionable value.

When we first started tinning oil-engine bearings, we found that the babbitt would apparently be well anchored when the job was finished, but would break loose again after the bearing had been in service for a while.

Experience taught a number of valuable lessons, the chief being that to pour the metal immediately after tinning the bearing gave a better bond through not giving time for the tin to oxidize. We also learned not to run too much metal and so avoided shrinkage stresses, which would tend to loosen it. It was also thought that if any good resulted from peening it would be greater as the result of working with the hammer on a surface that would be nearer the final running surface and without having a heavy cushion of babbitt between. Overheating appeared to result in the formation of spots of crystalline antimony, rendering the hardness of the bearing surface irregular and causing cracks to form in the vicinity of the crystallized spots.

We must assume that no one is going to be set the task of running a bearing who is not familiar with methods

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of handling the metal, and that if he needs advice on the one all-important subject of temperature, he will obtain it from the metal manufacturer, who knows more about it than anyone else.

When the right kind of metal is run correctly in a bearing that has been properly tinned, perfect adhesion will occur over the entire surface and no gas pockets

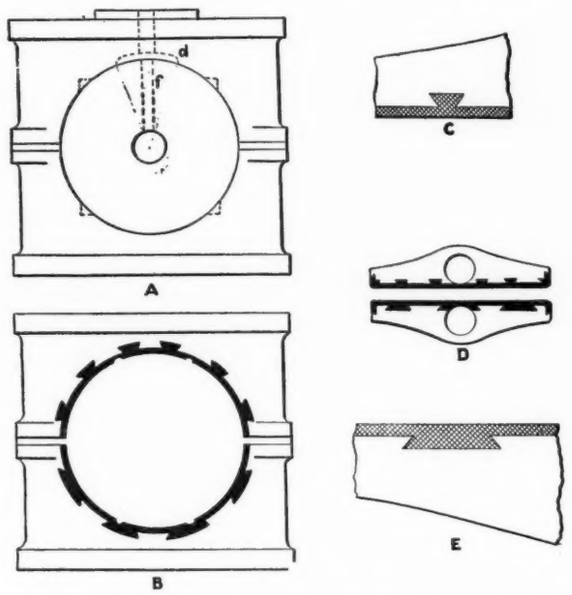

Fig. 1—Methods of bonding babbitt to bearing shells

will form. If they exist, or if the metal does not form a perfect bond, we cannot rectify these conditions by hammering the babbitt, save perhaps to close the gas pockets. If we disturb the original cast of the metal with hammering, we may weaken or crack it, which would be worse than to leave it free of support over small surfaces. If we peen it with light blows, we will not harden it enough to help its wearing qualities materially. The only really useful feature of using the hammer on babbitt may be summed up in the one feature of testing for tightness of the metal. Reference is, of course, made to hard babbitt such as is used in oil-engine bearings. Line-shaft bearings and sawmill babbitt are another matter entirely.

We have passed most of the troublesome stages of development of slow-speed heavy-duty oil engines. One successful manufacturer of these designs the bearings with very large dovetail anchorage spaces for the babbitt, believing that peening would spread the metal into these spaces with no possibility of breaking the babbitt at the corners of these openings. He also believes that comparatively small anchors of steel in a large body of babbitt make a more substantial job than the reverse condition. In short, he cast the babbitt over steel anchorages in place of casting babbitt anchorages into small openings in the steel. The method was correct, inasmuch as the bearings never gave trouble, although the extra cost of babbitt had to be compensated for in better service obtained, and it was no small item since the engine was one of 2,000 hp. In engines of smaller size and high speed this method would be of questionable value, since the anchorages would be small of necessity and the extra weight would tend to increase inertia forces in the crank bearings on high-speed jobs.

In the development of high-speed engines in which the babbitt is very thin, the question arose as to whether bonding could not be substituted for anchor lugs. Numerous attempts with the ladle and mandrel proved that this could not be done successfully, but the centrifugal process proved that the opposite was true. The metal has been so well bonded by this process that in a test a bearing shell was broken in the middle and the babbitt broke with it without peeling away from the steel or coming loose.

There is nothing wrong with this centrifugal method. Bearings in service have proved that to be true. If peening forced the cold metal into small depressions and produced a perfect mold, centrifugal force does this better and more uniformly. If in the spinning process the metal is poured too hot and the base metals find their way to the outer circle, as is sometimes declared to be

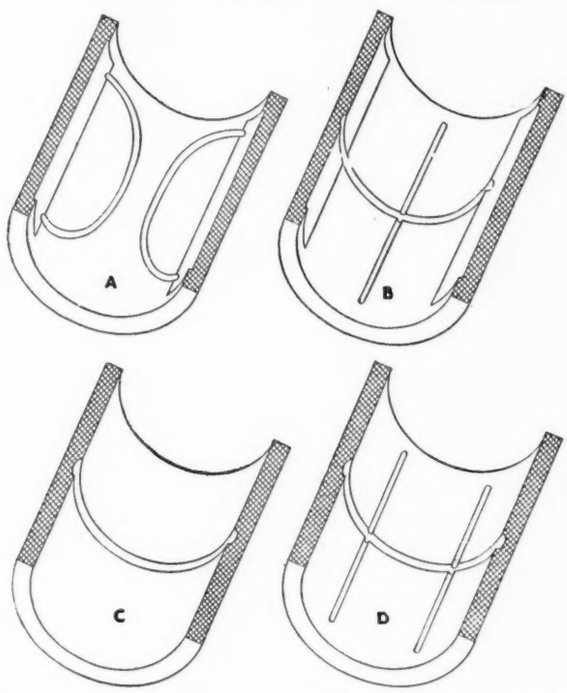

Fig. 2—Types of oil grooves found on engine bearings

true, they would also find their way to one end of a bearing poured in the regular way. Surely, we should not pour burned metal into any bearing.

Unfortunately, all plums are not sugar-coated, and the centrifugal process is one of them. Manufacturers employing this method are not divulging many of their secrets—not more than is necessary to prove the superiority of their methods. Their equipment is more expensive than a few mandrels and ladles, although in a

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number of plants an old lathe has been rigged up to spin the bearings, which are sealed on the ends with rings to hold the babbitt which is poured in through a funnel from an ordinary ladle. Of more importance than the equipment is the skill of the mechanics, who are trained in the special process, the rudiments of which may be understood readily but the actual performance of which cannot be accomplished in a few experimental trials. That most shops will take it up in due course of time goes without saying.

This process applies with equal value to large bearings, but we have some very large ones in oil engines, and their design helps or hinders the centrifugal process somewhat, because it is much easier to run a bearing that has been made in one piece and divide the halves later. If this is not done, a perfect dam must be made between the halves to prevent the escape of the metal while the bearing spins.

If to hammer the babbitt is harmful, we must draw a second conclusion that to chisel oil grooves may also be harmful. Whether such is the case or not, the milling machine does a much neater and more satisfactory job when it can be used. To machine cut them will not disturb the metal.

No doubt it will not harm a bearing to cut small oil grooves with a chisel and hammer, but many bearings have large oil passages through which a continuous column of oil flows to the crosshead bearings under pressure. These are circular passages, such as shown in Fig. 2 at *B*, *C* and *D*, which can be made to best advantage while boring out the bearing. Sometimes it is not desirable to have the groove in the shaft register with the opening in the bearing continuously. This is generally the case in engines of the trunk-piston type where the amount of oil reaching the wristpin bearings must not be great enough to leak out and flood the inside of the piston, run down the piston skirt and trickle onto the cylinder walls, over-lubricating them. In this case the oil groove in the upper half of the crank bearing is cut fairly deep, but to a distance of only an inch or two around the circumference, as at *A* in Fig. 1, thus preventing the flow of oil from being continuous.

Step by step we are making some radical departures from what used to be considered good common sense. The pressure system of lubrication has taught most engineers the need of sealing the side pockets at the ends of the bearings, and in high-speed engines it has taught them that this side pocket is not entirely necessary, in fact, that it highly undesirable. Owing to the stresses involved, crankshafts, crank boxes and connecting rods must be made very heavy, even in high-speed engines, and the resulting large centrifugal force throws a heavy side pressure on the bearings, which, if relieved in the conventional manner, will break down the small wall of babbitt left as an oil seal and open the opposite side, letting the oil escape. The bore of the bearing will become elongated, and in a general way we will find that metal is needed in place of side pockets.

With the pressure system it is not necessary to provide longitudinal oil grooves except in large bearings. Where they are needed or considered necessary on high-speed engines, they should be comparatively small and be cut in the quarters of the bearing, not sides, top and bottom, as at *A* in Fig. 2. That they are not generally needed is due to the fact that the oil under pressure is constantly escaping and being constantly replenished in the bearing. With a groove cut around the middle of the bearing, as at *C*, there will be a constant flow of oil from all points on the circumference of the pin outward, and on the bottom of the crank bearing there will be an opening equal to the clearance, while such opening will exist on the top of the main bearings.

There is never any reason to cut an oil groove in the bottom of a bearing where the pressure is greatest, unless it is on a crosshead where the reciprocating movement does not carry a film of oil a great distance. Bearing surface and not oil grooves will support heavy pressures.

The draftsman should lay off the oil grooves, and in bearings in which anchorage is provided with the conventional dovetail, he should be quite sure that he does not lay off the oil groove where the babbitt is thinnest. Grooves cut in such a way that they almost completely cut the babbitt often start cracks that creep in many directions across the babbitt, which eventually crumbles and lets the shaft down.

All engines are not high-speed, nor do all of them employ the pressure lubricating system, so we cannot make all our work conform to methods that apply to these systems, nor should we. In engines that employ the drip system of lubrication and are of the slow-speed type, we can make no improvement over the old conventional method of generous side pocketing and heavy grooving that carries well under the shaft.

In some of the heavy-duty slow-speed engines in service we find bearings with cracked babbitt the renewal of which would be quite expensive if it were necessary, but in most instances no great harm comes of running with such bearings in an engine. If the babbitt is completely shattered, that is a different matter. Sometimes it will not stick to the bearing shell if turned bottom up, and of course that necessitates renewal. But with a few cracks here and there and the babbitt fairly tight, when the bridge gage indicates that the shaft is not settling, there is no occasion for immediate worry. In fact, it is possible that renewed babbitt will not last as long as the old. Peening around the cracks to tighten up the loose pieces has proved to be a temporary remedy, but generally such pieces loosen up again in service and shattered edges are found when they are again removed. Another repair that has been made with some degree of success is to puddle in new babbitt where a piece has come loose. The difficulty with this method is that it is impossible to clean out all the oil under the surrounding metal, and when the babbitt is heated, gas generates and raises through the patch, leaving porous spots.

When patches such as this are made, there will be no bond between the shell and the babbitt and cracks will again develop. Just how soon will depend upon how well bedded to the shell the patch may be.

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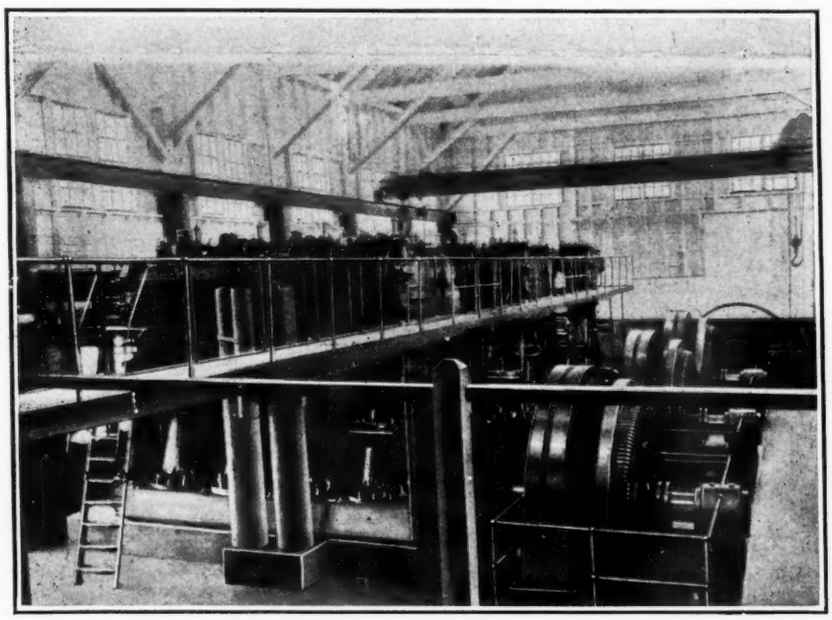
Cleaning Diesel Oil by a Centrifuge

By L. S. CHEETHAM*

WHILE engineers are convinced of the desirability of filtering and re-using lubricating oil for oil engines, the advantages of a clean fuel oil are not so generally appreciated.

From the experience of the Latouche, Alaska, plant of the Kennecott Copper Corp., it is profitable to pass the fuel oil through a filter. This plant consists of three 500-hp. McIntosh & Seymour four-cylinder, four-stroke-cycle Diesel engines direct connected to 350-kw. alternators, two turbines direct connected to 625-kva. three-phase, 60-cycle, 2,300-volt alternators and Erie City vertical water-tube boilers. The Diesels have been in continuous operation since 1918, and the turbines for a somewhat longer period.



Interior of the Latouche Diesel Plant

CALIFORNIA RESIDUUM OIL USED

The fuel used by this entire plant is a California residuum oil of about 19.0 deg. Baumé, having a heat value of 18,300 B.t.u. Until recently, the oil for the Diesels was used as received from the tank steamers, without purifying. During the last several months the oil has been cleaned by a centrifuge with gratifying results.

The oil is run through heaters and raised to a temperature of 170 deg. F. and then through the De Laval centrifuge, after which it is pumped into a separate fuel tank. The tabulation shows the average amount handled per hour, the percentage of water and of solids removed from the oil.

Previous to the time of installing the centrifuge, considerable trouble had been encountered with sediment lodging on the piston heads and valve seats. The latter, of course, caused delays while the valves were being removed. At times there would be found as much as $\frac{5}{16}$ of an inch of sand and sediment on the piston heads. The exhaust valves are giving excellent service at present, and there is no doubt that this is the result of cleaning the fuel oil.

The high content of moisture in the oil did not allow it to be heated to a proper temperature for good combustion before going to the Diesel; a temperature above 170 deg. resulted in gas formation. Since cleaning the fuel oil, it may be heated up to 195 deg. without any trouble.

The gravity oil system, which supplies lubrication for all the main bearings, crank bearings, compressor crank and piston bearing, contains about 450 gal. of oil. The system is connected to the centrifuge by a continuous bypass. The engines being of ordinary trunk-piston design, a great deal of carbon is carried by the rings into the crankpit together with the lubricating oil.

This oil is run through the purifier, and in an eight-hour run as much as nine pounds of sediment and carbon are removed. It can readily be seen that sediment and sand in the fuel oil would be bound to cause excessive wear on liners and pistons and also contaminate the lubricating oil. Approximately 150 gal. of oil per month is added to the gravity lubricating system.

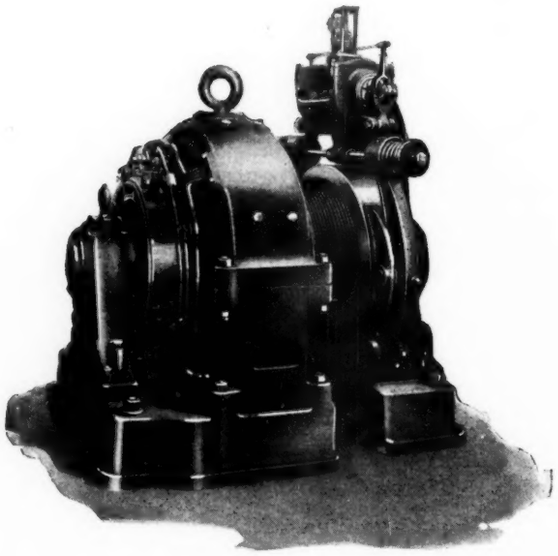
POWER-PLANT FUEL-OIL PURIFIER REPORT FOR MONTH OF MAY, 1927

Date	Hours Run	Gallons	Solids, Lb.	Gallons Water	Per Cent Water	Per Cent Solids
1	8	2,643	6	29.5	1.19	0.0291
2	7	2,314	5	....	.....	0.0276
3	22	6,224	10	....	.....	0.0206
4	8	2,510	5½	25	1.01	0.0268
5	18	4,957	7½	....	.....	0.0194
6	7	2,324	6	24	1.10	0.0331
7	15	4,551	6½	46	1.08	0.0183
8	.....	.....	.....	....	.....	.....
9	.....	.....	.....	....	.....	.....
10	6	1,802	4½	....	.....	0.0302
11	8	2,264	5½	....	.....	0.0311
12	16	3,872	7	....	.....	0.0231
13	6	1,666	5	....	.....	0.0384
14	6	1,823	5	....	.....	0.0351
15	8	2,432	6	24	1.06	0.0316
16	4	1,068	3½	....	.....	0.0419
17	6	1,950	5	....	.....	0.0328
18	10	3,574	6	37	1.10	0.0215
19	13	3,750	6	....	.....	0.0204
20	13	3,244	6	....	.....	0.0236
21	12¼	3,028	6	....	.....	0.0253
22	.....	.....	.....	....	.....	.....
23	13	3,957	6½	45	1.21	0.0210
24	13	4,098	6½	47	1.22	0.0203
25	.....	.....	.....	....	.....	.....
26	5	1,491	4½	....	.....	0.0386
27	12	3,103	4	....	.....	0.0165
28	12	3,162	4¼	....	.....	0.0172
29	.....	.....	.....	....	.....	.....
30	13	3,588	5	....	.....	0.0178
31	7	1,941	4¼	....	.....	0.0280
Total ...	268.5	77,336	146¼	277.5	1.134	0.0242

*Master Mechanic, Kennecott Copper Corp.

ELECTRICAL
Operation and Maintenance

Equalizing the Load on Elevator Cables



Increases the life of the cables, reduces the wear on the sheave grooves and improves elevator operation

By D. R. PADDOCK
Engineer,
Evans Elevator Equalizer Company

EQUALIZING the stress on elevator cables has been a subject of much discussion and experimenting, particularly since traction-type elevators came into general use. It is today becoming generally realized that some methods of rope equalization must be used in connection with traction-type elevators in order to keep the elevator equipment at a high standard of efficiency and prevent undue cable wear.

The Evans elevator cable equalizer, shown in Figs. 1 and 2, was designed for the purpose of overcoming difficulties encountered by uneven loading of elevator ropes, due to stretch, also to differential travel caused by uneven wear of the elevator sheave grooves. Where used, it has prolonged the life of ropes from 25 to 50 per cent, depending upon conditions of the individual elevator installation, and has, by eliminating rope slippage, reduced the wear on the traction-sheave grooves over which the cables pass.

With this device each pair of cables connects to the ends of an equalizer bar *B*. The center of the bars connects to a sheave *S*. Where there are six cables, as in the figure, there will be three equalizer bars with their sheaves attached to the car crosshead by an equalizing cable. These sheaves allow free movement to equalize the load on each pair of hoist cables, and the bar *B* equalizes the load between the individual cables in each pair. This adjustment maintains an equal distribution of load among all the cables.

This equalizer is a combination of the ordinary bar equalizer, commonly used on drum-type elevators and an equalizing cable which serves to effect the equalization between the vertical bars in the equalizing machine. It is constructed of steel throughout and has a much greater safety factor than the parts of the elevator to which it is attached. The equalizing cable is of special construction, having a breaking strain of 16½ tons for a single cable and 99 tons when compounded. It is made flexible for passing over small sheaves and should last for long periods provided it is kept lubricated to prevent rust and corrosion. All sheaves have self-lubricating graphite bronze bushings which tend to minimize friction and allow the equalizer to work freely.

Two safety plates just below the equalizing bars, in Fig. 2, are bolted and electric welded together. They are to keep the vertical bars in position and are a safety feature in case of breakage of the equalizing cable. In this case the heavy shoulder on the lower part of the vertical bars would move upward until they engage the lower edge of the safety plates, transferring the load from the equalizing cable to the upper part of the equalizing machine. The safety plates are of sufficient size to carry many times the load to which they may ever be subjected.

ROPE STRETCH UNEQUAL

It is well established fact that wire rope stretches and where several ropes are fastened to a common point, without an equalizer, the load varies on the separate ropes. This causes the rope life of the entire group to be shortened materially, and it is impossible to know when one rope has more load than the others unless they be tested with scales, which is not the usual practice. It is impossible for a mechanic to cut the ropes evenly at the time of their installation, and even if they are cut as nearly so as possible, the various ropes have an uneven stretch. The hemp core may vary slightly in size and in hardness, and it is also affected by weather conditions,

ELECTRICAL *Operation and Maintenance*

sometimes causing the cables to vary in diameter and length.

On one elevator where an equalizer is installed one of the hoist cables stretched 18 inches in a few days, after installation. If it had not been for the equalizer this condition might not have been detected, with the resulting unequal loading of the cables and reduced life. In this case the unequal stretch showed up on the equalizer and the long cable was cut and resocketed twice to make it carry its proper share of the load. Experiences of this kind would indicate that, on machines where short cable life is experienced, unequal stretch of the cables may account for a large part of the cause.

The driving sheave grooves of an elevator are turned as nearly true as possible by the manufacturer, but in time they become worn unevenly, owing to the varying rope is increased or diminished accordingly, as is also the wear.

This means that some of the ropes must slip to keep somewhere near each other in length as the car travels. This slippage wears not only the ropes but also the grooves until it becomes necessary to regroove or replace the sheaves. This causes false stops by the operator, as the traction on the ropes varies in the grooves according to the conditions of the grooves, making it more difficult to stop the car level with the floors during regular service.

The equalizer minimizes this slippage by its movement as the elevator travels, to compensate for the lengthening and shortening of the ropes. With the equalizer bars adjusted evenly when the car is at the lower limit of travel, the movement of the bars as the car ascends and

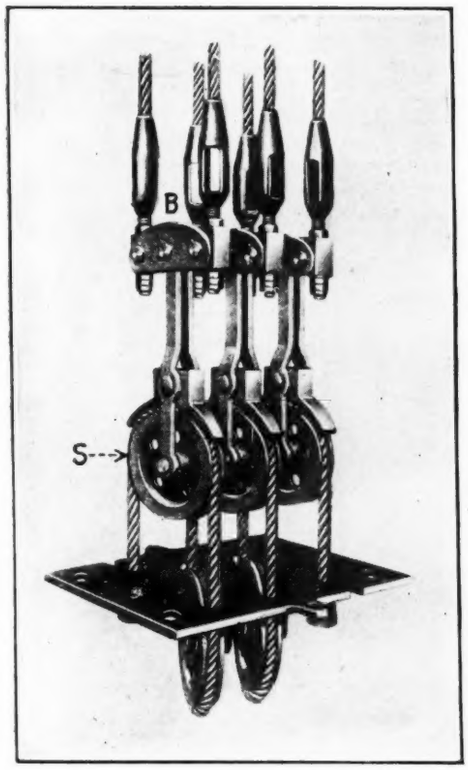


Fig. 1—Equalizer without safety bars

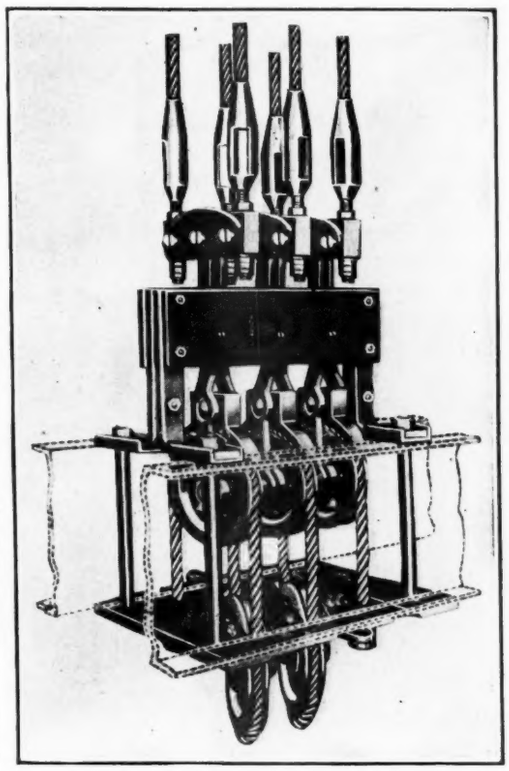


Fig. 2—Cable equalizer completely assembled

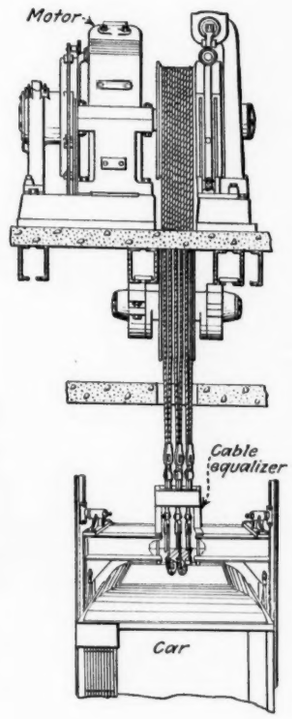


Fig. 3—Equalizer in car crosshead

loads of the ropes and the difference in rope diameters. The combination of rope conditions as mentioned, together with the sheave groove wear, causes a differential travel of the ropes when the elevator is operating and causes rope slippage, which shortens the life of both ropes and grooves.

It is a physical impossibility to equalize the strain on elevator ropes when a differential of groove wear exists, without an equalizer. The rope that passes over a higher or lower groove than the others travels either faster or slower as the driving sheave revolves, and the load on this their return to their normal position as the car descends show the amount of differential travel of the ropes which takes place during each trip of the elevator.

The use of the equalizer also increases the factor of safety of the elevator as each cable carries its proportionate load. Better and more economical elevator operation is obtained. Cable slippage causes false stops, which increase the power consumption and cause a loss of operating time. False stops also decrease the life of the cables, owing to increased bending in sections corresponding to the position of the car at the floors.

ELECTRICAL *Operation and Maintenance*

Motor Wiring Installed in a Substantial Manner

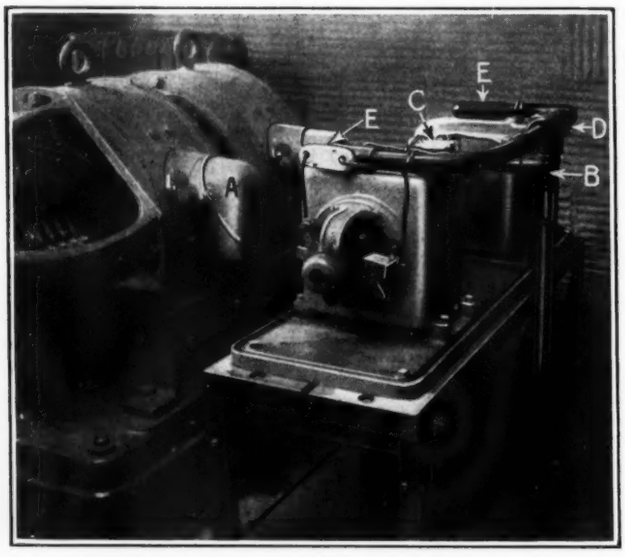
By M. E. Wagner

WHEN wiring small and medium-sized motors and generators, it is not always easy to obtain a good substantial job. Unless wiring is well protected against mechanical injury, there is always the danger that it will become broken or have its insulation destroyed. One shutdown of a machine may cost many times the expense of making the installation such that the failure would not have occurred.

Many modern motors are provided with a terminal box on the side of the machine as at *A* in the figure, which allows completely inclosing the wiring. The rigid conduit is run to within one or two feet of the motor, and then a piece of flexible conduit completes the run into the motor terminal box. If it becomes necessary to move the machine on its base to make adjustments, the flexible conduit allows this to be done without putting a heavy strain on the terminal box.

The method of wiring the two small motor generators shown at the right in the picture is of interest, as it shows how a substantial job was done without terminal boxes on the machine. The two machines are mounted on the same bedplate, and each has a commutator on each end, one for the motor and the other for the generator.

The motor ends face between the machines, and the wiring is brought up vertically to an "L" type condulet



Conduit wiring to small motor-generator sets

B and turns at right angles and terminates in a condulet *C* with a six-wire outlet. From here the wires go directly to the motors. In this case the conduit is self-supporting, but its size and the fact that it is made up good and tight make a substantial job.

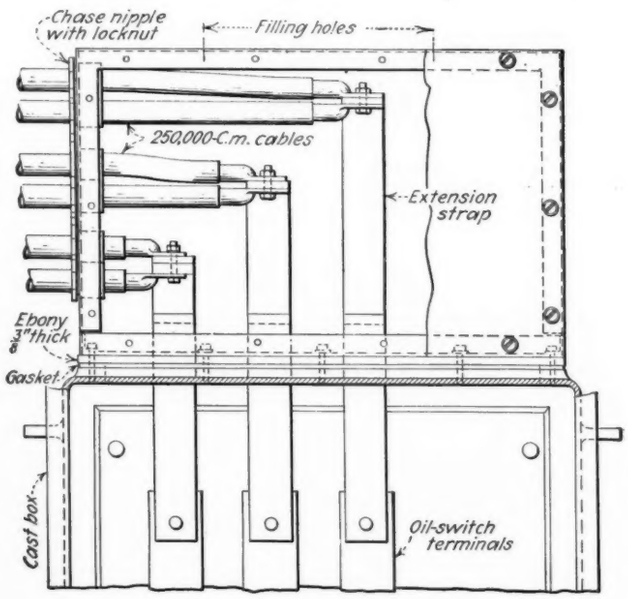
On the generators the commutators are on the outboard ends of the machines. On this job the conduit was brought vertically and branches in a "T" type condulet *D*. Then the two branches bend through 90 deg. and terminate in condulets *E* with two-wire outlets. From these outlets the wire leads down to the generator brushes. To give the conduit a rigid support, it is held to each generator with a clamp. This arrangement makes a substantial job and the wires are supported where they are not likely to be injured, and are located where oil from the bearings will not drip on them.

A Watertight Splicing Chamber

Maurice D. Smith

THE problem of making individual watertight bushings and wipes in 250,000-circ.mil lead-covered cables arose while bringing them from a network switch in a watertight box. This was satisfactorily accomplished as shown in the figure.

Extension straps of copper were bolted to the upper



Watertight terminal box for oil switch

terminals of the switch and projected vertically through insulating bushings in the top of the network switch box into a sheet-metal chamber. This chamber was made of $\frac{1}{8}$-in. material, with provisions for removing the top and front covers to facilitate installation of the cables. The horizontal outgoing cables passed through insulating bushings in the side of the metal chamber. The cables could vary in number according to the requirements of the installation and were bolted to the upper ends of the copper extension straps which were graded in length as shown. The front cover was replaced and hard compound, heated to such a point that it would just flow, was poured into the chamber until it was filled. The top cover was replaced and the compound allowed to harden, resulting in a satisfactory watertight job.

ELECTRICAL *Operation and Maintenance*

Control for Coal-Crusher and Conveyor Motors

By H. W. Wikle*

THE following arrangement was recently worked out by J. E. Sirrine & Co., engineers, of Greenville, S. C., and the writer, for operating two motors, one driving a coal crusher and the other driving a coal elevator or vertical conveyor, at the plant of the R. J. Reynolds Tobacco Company, Winston-Salem, N. C. It was desired, first, to start either motor separately from each of its three push-button stations; second, to stop both motors from any one of the six stations; third, to stop both motors by means of an overload relay if either motor became overloaded.

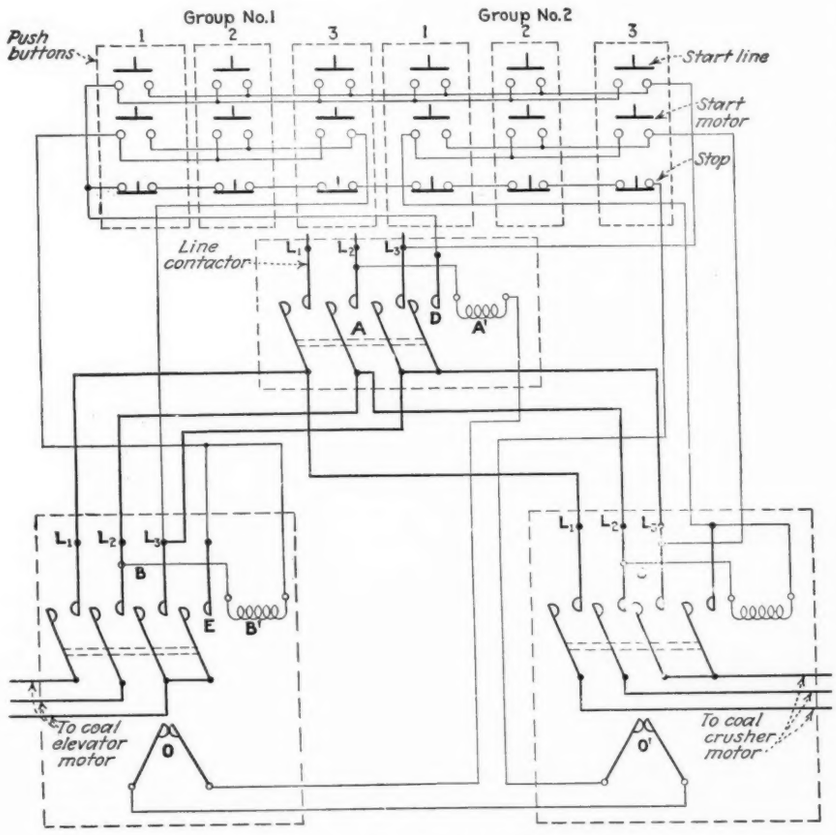


Diagram of control connection for coal-crusher and elevator motors

The diagram shows the control connections for the three standard magnet switches and six push-button stations. To meet the conditions in this installation, some changes were made in the internal connections of the switches.

To start either motor, the top start button in any one of the six stations is pressed, which causes contactor A to close. Assume that No. 1 start button on the left is closed. This completes a circuit from line L_2 on contactor A through coil A' overload relay contacts O and O', through all the stop buttons to No. 1 start button in No. 1 group, through this button and to line L_3. Making this circuit alive causes contactor A to close and supplies power to both B and C contactors. When auxiliary contact D closes on contactor A, it provides a circuit from the left-hand stop button to line L_3, without going through the start button. Therefore, after the contactor has closed it will remain closed when the start button is released.

The middle horizontal row of buttons in each group is used to start the individual motors. Closing the middle button in No. 1 station of group No. 1 completes a circuit from L_2 on contactor B through coil B', the push button and returns to line L_3. Energizing coil B' closes contactor B and starts the elevator motor. When auxiliary contact E closes, it completes a circuit for coil B' from line L_2, through coil B', contact E and to line L_3, so that the start push button can be released and contactor B will remain closed.

Any one of the middle buttons in group No. 2 can be used to start the crusher motor in the same way as the middle button in group No. 1 is used to start the elevator motor.

To stop the motors any one of the six stop buttons may be pressed, which will open the circuit through coil A' and allow this contactor to open, and cut the power out of both motors. An overload on one of the motors will cause either contact O or O' to open and interrupt the circuit of coil A', which will allow contactor A to open, as when one of the stop buttons is pressed. Thus both motors will be shut down automatically.

It was desirable that when one motor was shut down for overload the other would also be stopped. This was accomplished by putting the overload contacts on one motor switch in series with that on the other, and these in series with the coil on the master contactor. All six stop buttons are connected in series and in the circuit with the overload relay contacts, consequently pressing any one of the overload buttons will shut down both motors.

Although the push buttons are shown grouped in the diagram, they were located at convenient places about the equipment so that the operators could stop and start the motors at will. This is a preferable feature, as coal-handling apparatus covers considerable area and it would be inconvenient for the operators to go to the same location each time the motors are to be started. Furthermore, in case of emergency it is highly desirable that stop buttons be where they can be conveniently reached.

*With the General Electric Company, Atlanta, Ga.

EDITORIALS

False Impressions

"HOW is business?" inquires the visitor. "Not so good," replies the manufacturer. "There appears to be a lot going on, but competition is keen and I am not getting my share."

This colloquy is common nowadays. It represents the individual viewpoint traceable to the buyers' market which has existed for some months past. Such is invariably accompanied by increased solicitation of bids, and the proportion of orders secured to bids submitted is obviously less. This is likely to create a false impression in the mind of the manufacturer as to the condition of his business, even though it may be up to normal in the aggregate, and the same volume with fewer bids would be regarded as satisfactory.

That the manufacturer is likely to view the condition of his industry from the more or less narrow angle of his own business is natural, but in these days of interdependence of industries it is necessary to get the broader picture before drawing conclusions.

Radiator Performance

A RADIATOR performs its intended function when it heats a room so that the occupants are comfortably warm. Its capacity to accomplish this is difficult to express in a manner useful to the varied requirements of heating practice.

Radiators have in the past been rated according to the actual square feet of external surface they presented. Their capacity is now based upon the actual heat output in B.t.u. per hour, or in units of equivalent square feet of radiation equal to an output of two hundred and forty B.t.u. per square foot per hour under specified conditions of room and radiator temperature.

Of little or no value to the heating engineer was the square-foot rating of a radiator when applied to various types of radiators. It has also been shown by the work of a number of heating engineers that ratings based on heat output are not always a true measure of the capacity of a heating unit to perform its intended function.

Tests have shown that under certain conditions one type of radiator condensed 7.9 lb. of steam per hour while heating a room to a comfortable temperature, whereas under the same conditions another radiator required 16.3 lb. of steam to produce similar conditions of comfort in the same room.

The higher steam consumption of the one radiator is said to be due to its heating the air near the ceiling of the room to a temperature considerably higher than the comfortable temperature required at the breathing zone. The other radiator heated the room more uniformly and consequently required less steam consumption. The increased heat output of the less efficient radiator is largely waste heat, since it contributes little toward the comfort of the occupants and increases the heat loss from the room. Radiators do not necessarily perform in the same manner when placed in rooms of different size and shape, and it is entirely possible that the relative steam consumption of the two radiators, when functioning under other conditions, may be reversed.

All of this points to the necessity for care in selecting the type of radiator to be used in each application and to the need of information showing the peculiarities of various radiator types.

Power Plant Economy in Terms of Finished Goods

DID you ever visit a plant where the power services—steam, electricity, compressed air, or whatnot—were generated with the highest possible economy and then wasted right and left in the manufacturing departments? One large chemical plant, for instance, operates with a boiler efficiency of eighty-three per cent and generates electric current in extraction turbines for a very low cost. But this same plant has insulation only on the steam mains in the manufacturing departments, the branches being uncovered and free to radiate. Also, mechanical power is applied by lineshafts and belt, from motors so overpowered that not more than twenty-five per cent of the motor capacity is ever in use at any one time. And the shafts and belts are poorly maintained, increasing the loss.

Plants as bad as or worse than this are so common as to arouse but little comment. And, too often, the management will think that, because the power plant itself sets a high standard, all has been done that can be to insure the economical use of power.

This is all caused by a wrong idea of the place of power in the plant. Power is not a thing apart, but is an essential factor in the production of the finished products of the plants, whether these be soap or locomotives. Power generation, transmission, application and maintenance must be considered together, as parts of the manufacturing process. It is the cost of the B.t.u. in the finished goods that counts, and economy must not stop at the power plant door.

How High Air Preheat?

THE use of preheated air with power plant boilers has increased with amazing rapidity in the last few years. Air preheaters are being installed both in plants with stokers and in pulverized coal plants. As a result a number of new problems in the maintenance of boilers and furnaces have arisen that are still bothering the power house designer and operator. Among these is the question regarding the highest degree of preheat that it is economical and desirable to secure.

The answer to this question is dependent on many factors connected with the plant as a whole. For instance, if many stages of bleeding on the main turbine are not employed, the temperature of the feed water may be such that some economizer surface is warranted. In that case the degree of air preheat that is attainable will be limited by the temperature of the flue gases leaving the economizer. One may have particularly high boilers in the plant which reduce flue-gas temperatures to moderate amounts, which again limit air-preheat temperatures. Also the furnace walls may be able to stand only certain limited temperatures, and this may fix allowable air temperatures.

New forms of boilers are being offered with air preheaters that may be operated at high ratings and may produce quite high preheated-air temperatures. Are there limits to such applications?

Pumping Water for Hydro-Electric Plants

IN EUROPE pumping water for use in hydro-electric installations has been developed to a considerable extent, but in this country very little has been done with such developments. Europe has about forty such projects in operation or under construction, to only one in this country, which is now about ready to go into operation. Our power systems, which are more extensive than those in Europe, should offer many economic opportunities for pumping water at certain periods of the day or year to be used for power generation at others.

Conditions under which it may be economical to pump water for power generation are about as varied as the combinations involved in power-system operation. Run-of-river plants operated in parallel with plants supplied from large storage reservoirs, provide conditions under which it may be economical to pump. If, during the high-water period, the run-of-river plant can produce more power than there is a market for, the excess may be used to pump water into the storage reservoirs of other plants.

This water would be obtained at practically the cost of pumping, since the excess power from the run-of-river plant has a low value. In some cases it may be advantageous to operate the wheels of the run-of-river plant at full gate to relieve the spillway as much as possible. The pumped water is available to carry either base or peak load when the run-of-river plant has insufficient water, and thus delay the time when steam plants must be put on the system.

It may seem like a paradox, but at least one pumping plant has gone into operation that will at times use power generated in a steam plant to do some of the pumping. This is economically possible on account of the difference in the cost of off-peak power and peak power. Off-peak power in a steam plant, from a unit that would otherwise be partly loaded, is worth only about the cost of coal. At five dollars a ton for coal delivered in the furnace and one and one-quarter pounds per kilowatt-hour, the power cost is about three mills per kilowatt-hour.

Assuming a fifty per cent efficiency for conversions from the steam plant busbars to the hydro-electric plant busbars the cost for water is about six mills. Peak power may cost, to produce, four or five times this figure, which leaves a large margin above the cost of water to pay operating charges. Where water can be used under a higher head for power generation than it is pumped against, the project becomes even more favorable. There are also other factors that are in favor of pumping water, such as improved efficiency of the steam plant and better operating conditions. Obviously, not every hydro-plant offers such an opportunity.

Extraction Engines

THERE is general recognition that the reciprocating steam engine possesses certain characteristics that make this prime mover especially adapted for a number of services. However, upon the advent of the steam extraction process, the engine largely gave way to the turbine, as the latter could be bled at various pressures, and the general belief was that steam could be withdrawn from a reciprocating engine only at the receiver. This required compounding and its attendant high first cost.

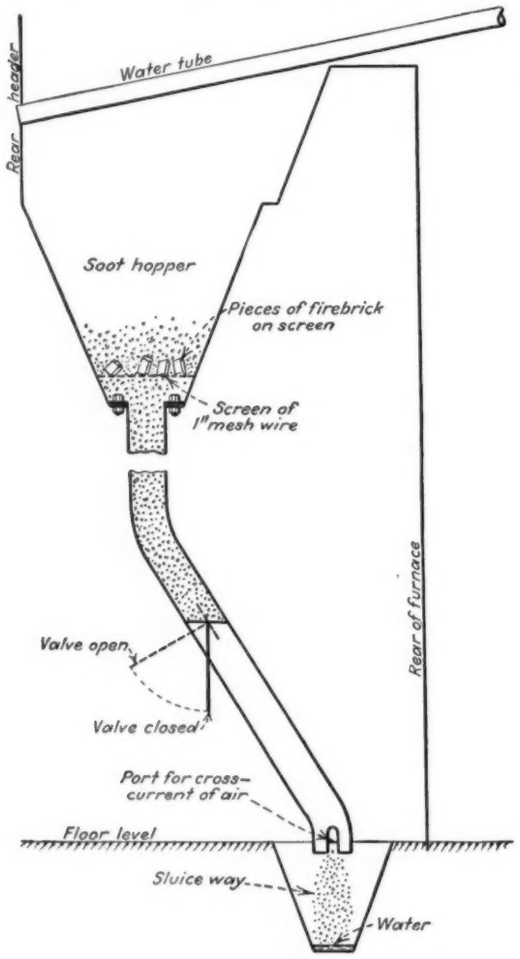
The single-cylinder engine can be arranged for bleeding at any desired pressure by the addition of ports and gearing along the cylinder walls. Bleeding of a uniflow engine was proposed several years ago, and recently such an engine has been built in Europe. In this country a multiple-cylinder uniflow has been built with a selective exhaust. In this design one, two or even six cylinders can exhaust at any desired back pressure while the remaining cylinders discharge into the atmosphereic line or into the condenser. Faults with the selective gear prevented the engine from being a commercial success, nevertheless, the germ of an excellent idea lies in this plan and it requires only good machine design and vision to develop the germ into a successful engine.

IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Butterfly Valve in Soot Hopper Pipe Obviates Soot Stoppage Troubles

AT OUR plant considerable trouble was had in finding a suitable valve for the soot lines of a water-tube pulverized coal fired boiler. As will be noted in the sketch, the soot transport lines empty into the ash sluice



Soot hopper pipe fitted with butterfly valve and air vent at bottom

way, which is always damp. The soot would cling to the side of the pipe and build across the bottom. This would rapidly cause a sweating in the pipe, and within a short time the line would become clogged, making it impossible to keep it clear. After several attempts had been made to eliminate this trouble, a butterfly valve was installed about seven feet above the outlet with the rod of the valve hanging in a vertical position when the valve was closed. An arch or opening was cut in the pipe above the floor level in order to have a current of air across the outlet, which prevents the damp air and condensate from settling on the pipe and clogging it.

The soot from the hopper is dumped into the sluiceway twice in each eight-hour shift, and the operator merely holds the valve in the open position. He also has the advantage of seeing that the soot is running by looking down at the arch in the bottom of the pipe. After all soot is out of the hopper, the operator can let go of the handle, and it will fall back into the closed position. The soot quickly accumulates on the butterfly valve after cleaning and forms a good seal against any leakage of air into the furnace. Formerly, the stopping of the air leakage was quite a problem owing to the trouble experienced in closing other valves.

This valve has been in operation over four months, and we have not had one case where the soot has collected around the inside of the pipe and stopping up the line. A one-inch mesh wire screen is placed about eight inches above the opening of the pipe to catch any broken pieces of brick which may get into the pipe and clog it up. It occurred to me that there might be some other concerns that are using pulverized coal who would find this idea worth trying out.

The regular type of slide valves which were tried in this line, were unsatisfactory, owing to the soot collecting around the slide and making it almost impossible to keep them airtight and free to open or close.

M. W. HORLEY, Boiler Room Engineer,
Holtwood, Pa. Holtwood Power Company.

Spare Feed Pump Used to Supply Water for Tube Cleaner

THE way in which we improved the operation of our tube cleaner and secured the necessary pressure to run it, may be of interest to other readers.

We were using vertical boilers and, as usual, the hose leading to the cleaner had to come through the manhole from outside. To use steam to drive the cleaner would make it rather disagreeable for the operator inside, and we did not have compressed air available, so water pressure was our only solution.

We got the water-driven cleaner into action and found not only that we had to use a long connecting hose or run a pipe up to the boiler, but that our water pressure was not sufficient to drive the cleaner through the heavy scale at the bottom of the tube.

Something drastic had to be done, as we were in need

of the boiler. Someone suggested hooking on to the feed-water connection inside the drum. Under ordinary circumstances it would be bad practice to use feed water for driving a tube cleaner, but in this case we fortunately had duplicate feed lines and pumps, so we started up the spare pump and pumped cold water through the duplicate line, adjusting our valves so as not to interfere with the boilers that were on the line.

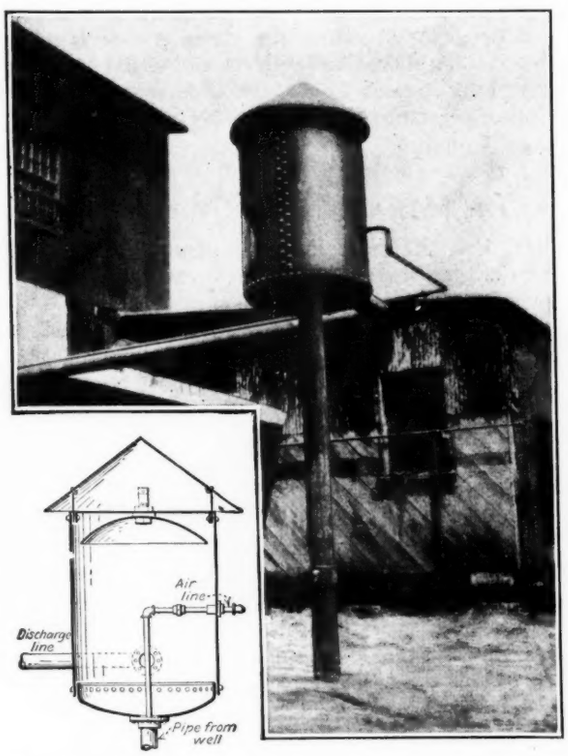
We obtained the desired pressure and the operator could control the supply from the inside of the drum, doing away with the man who was necessary to help him when the hose was passed through the manhole. We made up a special fitting for the inside connection and permanently adopted this method of driving the cleaner.

Port Arthur, Ontario, Canada. R. S. EDWARDS.

Air Separator for Air-Lift Pump

IN ORDER to prevent the water from issuing in gushes or spurts from an air-lift water pumping system, the device shown in the illustration was made from an old steam boiler dome.

The boiler was of the horizontal, return-tubular type and the dome was cut off at the boiler shell with an acetylene torch. A splasher was then made by bolting a disk to the center of a piece of flat iron that extended across the open end of the old dome, each end being bent to right angles and riveted or bolted to the sides of the dome. The disk was attached to the under side of the cross support with the concave side downward. The dome was then inverted and attached to the upper end of the well piping as shown.



Cross-section and piping connection to air separator

A 3-in. pipe line is connected with the side of the dome near its base and extends horizontally to the reservoir to which the water escapes from the separator. As the spurts of water issue from the well, they strike the under side of the disk and are turned back into the dome. A conical cover is attached to the upper end of the dome to keep out rain and trash and space is allowed between the upper edge of the dome and this cover for the escape of the air. The air line enters the side of the dome and descends the well piping as shown. This well, which is more than 400 ft. deep, is used to supply a modern ice factory with deep well water, but the device may be used with any system. L. M. JORDAN.

Cairo, Ga.

Locating Vacuum Leaks With Oil of Peppermint

LOCATING leaks in a vacuum system involving only a small number of connections is not usually an easy process, while in a larger system which is complicated by many connections to low-pressure extraction heaters, deaërators, valves, vacuum traps and other equipment, the job may be like searching for the proverbial needle in a haystack.

Leaks are generally located in vacuum systems by the candle-flame method or by filling the system with water and observing outside leakage.

The use of candles is unsatisfactory in many respects. Unless care is used, the candle may be passed over small or even large leaks without their being observed; it may not be used successfully to detect packing leaks around rotating shafts, owing to the fan action of the shaft on the flame. Where fittings and joints in the system are insulated, it is necessary to remove the insulating material before the candle flame can be used to detect leaks. Even when care is exercised, the candle method is slow and not always to be depended upon.

The water-pressure method requires that the system to be tested be placed out of service, which is not always possible, and in certain installations it may necessitate considerable labor and expense supplying and disposing of the clean water necessary to fill the system.

A method I have used for some time, which does not seem to be generally known, is that of applying oil of peppermint at possible sources of leakage. The oil is applied by pouring a small amount along the joint to be tested or by saturating a cloth with the oil and wrapping this cloth around the joint. If there is a leak the peppermint odor will quickly pass through the system and may be detected almost instantly by an assistant stationed near the atmospheric discharge of the air-removal apparatus. A short time interval should be allowed between applications at various points, to allow the fumes to pass through the system if there is leakage and the assistant to signal the condition after each test. This method is reliable in testing for leakage through the low-pressure gland packing on turbines using water for low-pressure sealing.

The method described is inexpensive and may be applied quickly with reliable results, without placing the system out of service. M. S. FITZWILLIAM,

Chief Engineer Arsenal Hill Station,

Shreveport, La. Southwestern Gas & Electric Co.

COMMENTS *from* READERS

Slagging of Tubes

WE ARE having considerable trouble with slag depositing on the bottom rows of tubes on our inclined-tube water-tube boiler. It is necessary to run the fire off the stokers at least every three weeks, and then send men into furnace to remove this slag.

Can some of *Power's* readers give me information as to how this trouble can be eliminated or reduced.

Newark, N. J. RICHARD N. SELDON.

* * * *

Boiler Feed Control of Brown Paper Company

IN THE article on the Brown Paper Mill power plant which appeared in *Power,* Feb. 14, there is one statement which we feel might be misleading to some readers.

Our entire plant was designed by George F. Hardy, consulting engineer, and boiler-feed controllers were originally installed. We omitted the use of these controllers, not owing to the digester load, as was stated in the article, but because of our feed-water conditions. We are using artesian well water and this has a tendency to foam and prime and, for this reason only, automatic feed-water regulators will not operate satisfactorily.

In fairness to the boiler and controller manufacturers and to our designing engineers we feel that this impression should be corrected, as feed-water controllers are accepted practice for paper mill installations with a widely fluctuating digester load. M. C. MCDONALD,

Monroe, La. The Brown Paper Mill Co., Inc.

* * * *

Why Blame the Motor?

I WAS much interested in the article, "Why Blame the Motor?" in the Jan. 10 issue. Too often, the motor gets blamed for conditions that are purely mechanical and that are in the machine to which it is connected. Many times the foremen in the different departments are likely to blame the motor when something goes wrong, and in some cases refuse to be shown where the trouble is. They take the attitude that their end of the equipment is all right, and if the electrical maintenance man has no jurisdiction over the machine, he sometimes has a hard time trying to convince the other fellow that something is wrong with the mechanical equipment.

Some time ago an occasion arose where there was a discussion as to the power requirements of a certain type of machine in our factory. There were about 60 machines of that type involved. The building was a five-story mill of reinforced-concrete construction about five years old. The motors had been running with a gradual increase in temperature and with a slightly decreasing output until their condition had become serious. Power consumption had increased 50 per cent in a number of cases and in one instance 97 per cent. A check on the lineshafts of the machines showed that the mill had settled enough to throw them out of line. Notwithstanding the discovery of this condition it was maintained by the foreman that the shafting was all right and larger motors were required. It required a service man from the manufacturer of the motors to support my report before the management decided that the shafting should be lined up. After the machines and shaftings were lined up, conditions returned to normal.

At another time, some new machines were to be installed. Two were set up by the manufacturer's men, and after a trial run a load test was made to determine the size of motor needed. It was found that about 1.45 hp. was required, and 1.5-hp. motors were decided on. However, when the additional machinery came in, the mill foreman in charge had them assembled by his own men. When tests were made, reports showed that these machines were using from 2.5 to 3.12 hp. A proper lining up of the machines by mechanics brought the power input down to that of the original tests.

I find that the hardest job the maintenance man has is to convince some department foremen that, once in a while, the machines need oiling, cleaning and checking up, as well as the motor, in order to maintain an efficient condition with respect to the machine and the power consumption per unit of output. E. S. BAXTER.

Ansonia, Conn.

* * * *

Increasing Fixed Charges

IN THE Feb. 20 issue, Edgar J. Kates in "Guessing Fixed Charges for a Proposed Power Plant," apparently guesses in his arithmetic.

He assumes an industrial establishment using 17,000 kw.-hr. per month with a maximum demand of 100 kw. He assumes a Diesel engine operating cost of 1.1c. per kw.-hr. This gives an operating cost of $187 per month.

He then proceeds to say that purchased power costs 2.28c. per kw.-hr., or $476 per month. My arithmetic makes this only $387.60 per month.

Mr. Kates assumes an investment of $15,000 necessary to produce the results mentioned.

If this industrial plant put the $15,000 in a safe investment at 6 per cent it would make $900 per year or, better still, if it put back the money into its own business, probably three or four times this amount. Furthermore, ten years is a long time and this industrial plant will probably have lower power rates before that, or at least it will want to have $15,000 ready to buy a better oil engine. The plant would probably not have maintenance and other troubles to worry about. It looks as if Mr. Kates has made an error of about $20,000. L. O. BUCKNER.

York, Pa.

[The rate upon which the calculations of Mr. Kates were based was 2.8c., the 2.28 was a typographical error —Editor.]

Why Not Cover the Flanges?

THERE are a number of smaller plants that cover their steam lines so far as the straight lengths of pipe are concerned, but omit the flanges. It is true that it is more complicated and costs more to cover the flanges than the straight run of pipe.

It seems to me that the flanges are the vulnerable parts of the steam line and are entitled to even more consideration than the straight pipe. Since the heat loss by radiation is a function of the area exposed, flanges give considerable area, and the smaller the pipe the greater the relative area of the flanges. In the smaller sizes of pipe the area of the flange may be equivalent to several feet of pipe. These flanges act like fins on radiators, conducting considerable heat to the surface by virtue of their weight and area.

Furthermore, I believe that the exposure of flanges to extreme changes of weather, to falling snow and rain, with considerable gradient from the inside of the pipe, subjects the joints to greater strain than if they were covered and maintained at more uniform temperatures. Exposed joints are more liable to leakage and ruined gaskets for similar reasons.

The only other advantage of exposed joints besides that of cost of covering, is the greater ease of repair and the avoiding of removing the covering. Rather than an advantage, I believe this increases the cost per joint by increasing the number of times the joint must be repaired. The cost of repairing a joint is considerable when one considers the shutting down of the steam line with possible loss of production, steam loss and danger in repairs if the steam valve does not seat properly, in addition to the actual cost of the repairs.

I fail to understand why joints are sometimes skipped in the covering of steam lines. C. W. STEVENS.

Tulsa, Okla.

* * * *

The Past and Present Chief Engineer

ONE can get a lot of ideas from reading the advertisements in technical publications. Recently, an advertisement gave me food for thought on a subject quite unconnected with the product it extolled. It was one of the conversational type of advertisements. Pictured at the top of the page was a turbine room with all the modern appurtenances. An experienced "Chief," oil stained and with broken shoes, was shown dispensing wisdom to a young assistant. Below the picture was recorded the conversation, highly colloquial and ungrammatical, in which the desirable qualities of Blank's equipment was brought out.

The article advertised is no doubt excellent, but instead of being filled with an acquisitive desire, my thoughts ran to the appearance and language of the chief. The pictured turbine room is intended to be typical of the best modern practice. Is the mediocre appearing chief and his poor English also typical, or did the artist make a mistake and show an engineer out of the past in charge of a plant of today? No criticism is intended for this particular advertisement or artist; it and he only reflect public opinion and the question is, Is public opinion of the chief engineer right or wrong? I feel convinced it is wrong.

In the days when 80-lb. hand-fired horizontal return-tubular boilers, single-cylinder non-condensing engines and Edison bi-polars were the rule, the chief engineer possibly was an uncouth, inarticulate individual with a pipe wrench in his hand and waste behind his ears. The "big boss" did not respect him because of his dirty finger nails, his week-old shave, and because he referred to "them" engines, and tolerated him only because he was "hard boiled" enough to get some work out of the firemen. He feared and avoided the "big boss" because of a decided inferiority complex which he attempted to disguise. With his coal shovel background he was never accepted or sought to be accepted as a social equal by professional men.

The old-time equipment has gone. In the better class of plant the boiler room has become a laboratory, the engine room a place filled with giant turbines rotating at high speeds, and the electrical equipment a collection of delicate apparatus. Isn't it reasonable to believe that the job of controlling this high-class equipment has developed a high-class man? Of course it has, just as medical research has developed the respected medical profession out of the ignorant leeches of ancient days. The old-time mechanically inclined workman has been succeeded by the technically educated engineer who respects himself and his job, and is entitled to respect from his fellowmen.

The chief engineer cringing in the boss's office has been replaced by the chief engineer advising the boss on technical matters, and the chances are even that the conference takes place in the chief's office. With increased knowledge has come an increase in the social graces. While he isn't too good to wear overalls when necessary, a starched collar doesn't hurt his neck and he knows that plus fours aren't correction factors in arithmetic. To those who know him, the chief engineer is an educated man and doesn't suffer by comparison with any professional class.

Alas, public opinion moves slowly, and at the present day fiction, the stage and the movies still portray the old-time chief engineer. To the average doctor, lawyer, merchant and minister the engineer is still the man with the exposed undershirt and the oil can—a man to be patronized and not at all the sort one takes to dinner at the club. Public opinion is wrong in its classification of the engineer, but public opinion never takes the trouble to correct itself and will cling to this inaccurate idea until the engineer shows himself in his true colors.

Unfortunately, engineers are usually retiring creatures outside of their jobs and are prone to yield position in civic, club and charitable affairs to members of the more vocal professions. Most of us know a number of chief engineers in charge of equipment literally worth millions and receiving compensation almost commensurate with their responsibility, but how many chiefs do you know that are members of their local board of education, of the golf club building committee, of the Red Cross drive, etc.?

Let the engineer hold up his head, take the part he is entitled to in affairs outside the plant, and show the world he is a citizen as well as an engineer, and public opinion will reciprocate at least to the extent that the man with the dirty neck and the oil can will not be the popular cartoonist's symbol for the engineer and perhaps to the point where salesmen will not try to work off their second-rate cigars on him. ELMER S. SMAIL.

Oak Park, Ill.

Amplifies Statement on Steam-Cooled Furnace Walls

IT IS reported on page 354 of the Feb. 21 issue that in the discussion which I offered at the Mid-West Power Conference on T. E. Murray's paper on steam generators, I said that "the solution of furnace cooling lies in steam-cooled rather than water-cooled walls."

I did not intend to convey this impression. What I did say was that the cooling of furnaces by water walls was not the only means, there being great opportunity for the employment of radiant superheaters, which would give us steam-cooled walls, and that radiant superheaters should be employed to the largest extent possible.

JOHN ANDERSON,
Vice-President in Charge of Power,
The Milwaukee Elec. Railway & Light Co.
Milwaukee, Wis.

* * * *

Operating Experiences in the Old-Time Power Plant

I DON'T know whether the new and modern power houses have as many thrills and laughs to offer as some of the older ones, but I will relate some experiences I had about fifteen years ago, and if such things occur in the modern plants, it would be interesting to hear about them. In the plant in question we had many types of prime movers and generators, consisting of Corliss engines, vertical and horizontal turbines.

My first thrill came with a 500-kw. 1,800 r.p.m. vertical turbine. This machine operated satisfactorily when the load was steady, but if the load varied it was problematical whether the turbine would overspeed or slow down. When it slowed down, the only trouble was lowering of the voltage and frequency, with perhaps a loss of load; but when it speeded up, everybody not connected with its operation ran for safety. This was due to the fact that at high speed the governor, which was connected directly to the top of the spindle, would break off, and the various parts would fly in all directions.

On one occasion I was watching this and two other larger turbines when it overspeeded. I ran to the throttle and tripped the quick closing valve. I was a second too late for, just as I shut the valve the governor let go and I ducked under the platform until the parts returned to terra firma.

In the space of two years this governor let go five times, and it was just luck that no one was hurt. Various parts of the building and switchboard were damaged, but not seriously.

In this plant there was a 75-kw. 3,600-r.p.m., turbine-driven exciter. In preparing one of the main units for the line, it was necessary to start this exciter. The oiler usually did this, but a new "expert" watch engineer allowed no one but himself to start things. He opened the throttle on the exciter and it refused to start. He sent the oiler for a 3-ft. Stillson to turn the shaft, and it still wouldn't go. He fooled around about half an hour, but was unable to start it. As he was an expert, no one dared tell him anything or suggest where the trouble was. There was no other exciter available and the switchboard operator was getting nervous, as the load was increasing.

Several of the station gang had gathered around watching the efforts to start. The chief came along and the engineer told him a long story about "stripped buckets and broken shafts." The chief went over and opened the exhaust valve, then the throttle, and away went the turbine.

JOSEPH O'BRIEN.
Rosedale, L. I.

Answers to "What Do You Know?"

The questions are on page 461

Ans. 1—The area of circle whose diameter is D, is equal to $\frac{3.1416D^2}{4}$ and its circumference is equal to $3.1416D$. Setting these two expressions as being equal, we have $\frac{3.1416D^2}{4} = 3.1416D$ or $D = 4$ in.

Ans. 2—The simplex uses less steam since there is less clearance in the steam ends to be filled.

Ans. 3—About fourteen years ago an American steam engine manufacturer built one tandem-cylinder horizontal Diesel. In Europe a number of such units have been built.

Ans. 4—If the fluid is the same in both cases and the existing vapor pressure identical, the liquid will boil upon the application of heat into saturated vapor, and this vapor will condense at the same temperature upon the removal of heat.

Ans. 5—The fusible plug should be in an outside tube, not less than one-third the tube length from the lower tube sheet.

Ans. 6—It is cooled in three ways—radiation through the tower walls, by direct contact with the up passing air and by evaporation. The first is negligible.

Ans. 7—In older designs the superheater requires flooding, but manufacturers are now making superheaters that are strong enough to withstand the heat without flooding in case of convection superheaters.

Ans. 8—Water hammer is caused by the presence of cold water that has been trapped in low points of the piping. The water of condensation lodging at such points cools when the supply of steam is shut off, and when steam is again turned into the piping and passes the pockets, the pounding occurs. This is due to the sudden condensation of the steam, which causes a vacuum in the piping, and the water, in endeavor to fill it, produces a snapping as of hammering on the pipe.

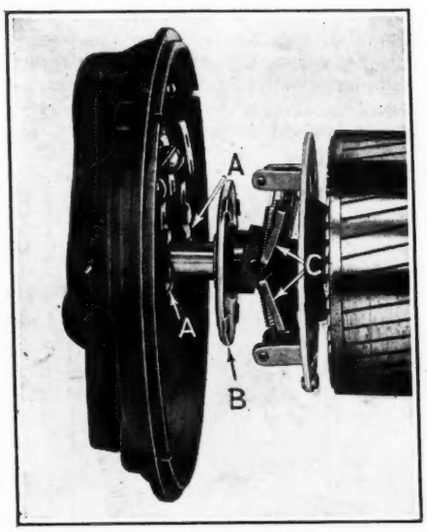
Ans. 9—The present kva. = kw. ÷ power factor = $180 \div 0.60 = 300$. The reactive kva. = $\sqrt{\text{kva.}^2 - \text{kw.}^2} = \sqrt{300^2 - 180^2} = 240$. At the new power factor the kva. = $180 \div 0.85 = 212$ and the reactive kva. = $\sqrt{212^2 - 180^2} = 112$. The capacity of the static condenser required equals the difference in the reactive kva. at the original power factor and that at the new power factor, or $240 - 112 = 128$ kva. The condenser losses have not been considered, but these represent only about $\frac{1}{2}$ per cent of the condenser's rating and may be neglected for all practical purposes.

Ans. 10—The engine with the larger clearance will show the greater m.e.p., since there is a greater volume of steam at the initial pressure to expand, and consequently its expansion line will be above that of the 4 per cent clearance engine.

New and Improved EQUIPMENT

Improved Switch on Split-Phase Motor

A NEW switch that is capable of 500,000 starts and stops is one of the principal features of the new split-phase motor of the Wagner Electric Corporation, St. Louis, Mo. On test, one motor started and stopped nearly one million times and was still in



Switch in position on rotor shaft

operating condition. The end of the rotor, the automatic switch and one bearing-end bell are shown in the figure.

The stationary contacts for the starting-winding circuit are at *A*. These contacts are made of a bronze strip formed in such a way as to produce a spring tension on the brass contact ring when the motor is not running at nearly full speed. The starting-winding circuit is completed by a brass contact ring on the disk *B*. When the motor is not running, this ring is held in contact with contacts *A*, by the governor spring. Both the contact ring and the stationary contacts are mounted on bakelite.

In the figure the governor weights *C* are shown in their correct position when the rotor is stationary. When the rotor comes up to speed, centrifugal force causes the weights *C* to move the right and, in doing so, pull the contact ring *B* away from the stationary contacts. This operation opens the starting winding when the rotor reaches nearly full speed. The governor moving parts are carried on the shaft by a zinc-plated collar that rides freely on the shaft.

The switch is so constructed to give a wiping contact and to open the circuit with a quick break. Other features of this motor are wool yarn lubrication, formed steel base and dripproof end bells.

Morrison Helical-Gear Speed Reducer

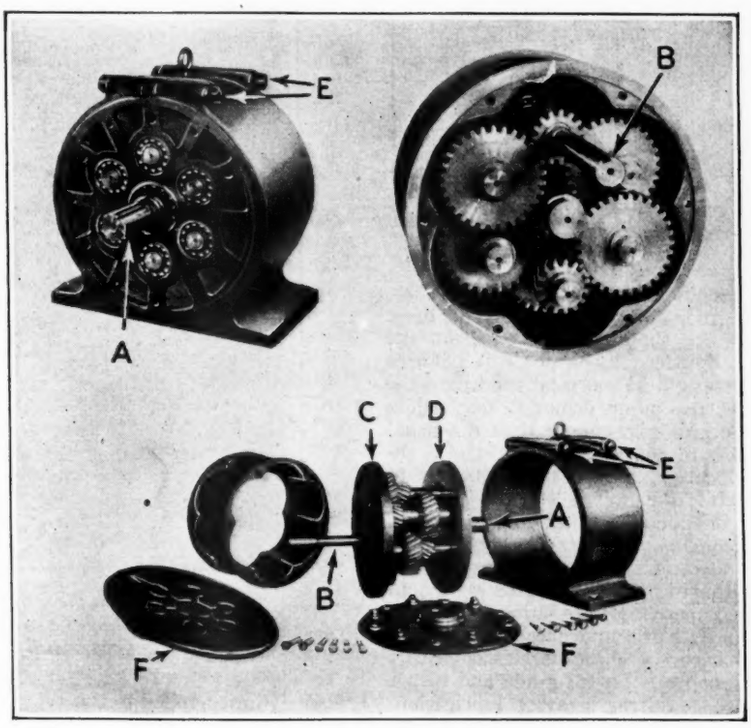
THE quick adjustability of the high-speed shaft of any level to suit the motor to which it is to be coupled is a feature of the speed reduction unit recently introduced by the Morrison Machine Company, Paterson, N. J.

Although the gear illustrated was developed primarily for use with a line of machines which the company manufactures, it is readily adaptable to various services in the industrial and power plant fields and is now available in a number of sizes.

Referring to the illustration, steel helical gears are used, with a ball radial-thrust bearing on each end of each shaft. The slow-speed shaft *A* is located in the center with each of the countershafts, including the high-speed driven shaft *B*, midway between the center and the outside on a common center circle.

The complete gear train is carried between two disks *C* and *D* which are clamped in the housing by means of two clamp bolts *E* at the top. The adjustment of the high-speed shaft is accomplished by loosening these clamp bolts and turning the gear assembly to bring the high-speed shaft *B* to the desired level or position, then locking it there by tightening the bolts. The gear and bearing assembly is completely inclosed by end covers *F* which bolt to the bearing disks; this serves to lock the gear assembly securely in position and makes the housing oiltight. The gears run in an oil bath, and an indicator is provided to show the proper oil level.

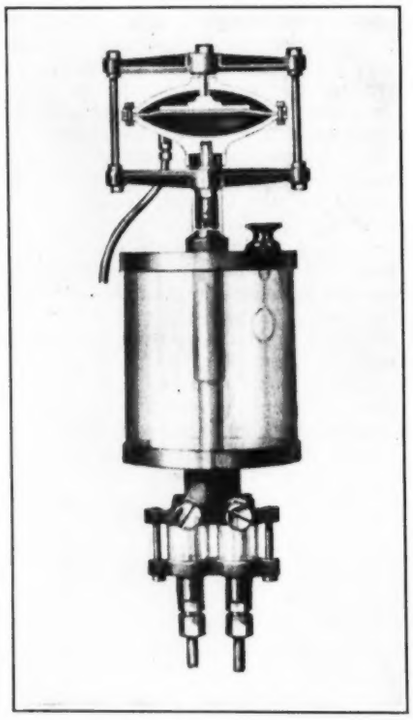
The unit is built in standard types and sizes giving from 2 to 1 to 79 to 1 reduction.



The Morrison Speed Reducer

Yeomans Automatic Oil Economizer

MOST vertical-shaft centrifugal pumps installed for pumping sewage and drainage are equipped with automatic start and stop control, and many of these installations may be idle for long periods of reduced inflow, particularly reserve units arranged to come in automatically under peak conditions. If the guide and thrust bearings of these pumps are supplied with oil from the usual sight-feed lubricator, the chances are there will be more oil used than the duty of the pump demands, for unless the operator gives more than the usual attention to an automatic outfit in a remote location, the oil may continue to flow while the unit is shut down.



Oil economizer for automatically controlled vertical-shaft pumps

To obviate the foregoing difficulty, the Yeomans Brothers Company, 1433 Dayton St., Chicago, has brought out the automatic oil economizer shown in the accompanying illustration. This device consists of a multiplex lubricator of liberal capacity with individual adjustable sight feeds for all guide and thrust bearings requiring gravity lubrication. Two sight feeds are shown in the illustration, but the number may be increased as required. Ordinarily, the economizer is mounted on a flanged pipe support on the sump cover or the baseplate close to the motor.

Control of the flow of oil is effected by the diaphragm mounted on top of the lubricator and connected by copper tubing and piping to the pump discharge. When the pump is in operation, the discharge pressure is transmitted to the underside of the diaphragm, pushing it upward and, by means of the frame around the diaphragm, raising the needle valve that controls the outlet to the oil container. As soon as the pump is shut down and the pressure under the diaphragm is released, the diaphragm settles back to normal position and in so doing stops the flow of oil to the bearings by closing the needle valve. In this way the oil flow is maintained only when the pump is running, and the only attention necessary is the occasional filling of the oil container.

Wick-Type Guide-Rail Lubricator

THE old method of lubricating elevator guide rails by a man standing on top of the car with a pot of grease which he applies with a brush has many objections. First, it is a dangerous job and requires taking the car out of service to do the work. When the lubricant is first applied to the rails, there generally is an abundance, but this begins to diminish just as soon as the work of applying the lubricant is completed and it continues to do so until the next time the grease is applied. Therefore, with hand lubrication the quantity on the rails varies from too much to none at all, depending on the attention given to this work.

To insure better lubrication of the guide rails, automatic methods of doing this work are being given extensive attention. In Figs. 1 and 2 is shown a new stationary guide-rail lubricator of the wick type, developed by the Otis Elevator Company, New York City. A square felt wick *W* leads from the bottom of the oil reservoir up through an adjusting device *A*. From the adjusting device the wick leads down through a tube to an oil distributor *D* on the guide rail, Fig. 1.

By capillary attraction and a siphon principle the oil flows through the wick from the reservoir to the oil distributor on the rail. From the distributor the oil flows by gravity down the rail and is distributed by the guide shoes. The rate of oil flow to the rails is controlled by tightening down or releasing the adjusting clamp *A*.

The type of lubricator shown in Fig. 1 is mounted at the top end of the guide rail. In places where the top ends of the guide rails are not accessible or where the overhead clearance is limited, the lubricator with an extension, Fig. 2, may be used. This type can be located conveniently above the tops of the guide rails, where they can be easily inspected and filled. The wick is extended through a flexible metal tube from the reservoir to the oil distributor on the guide rails. This arrangement adds to the ease and safety of refilling the reservoir, obviates the necessity for taking the car out of service while the oil is being replenished, assures proper lubrication of the rails and reduces the cost of maintenance.

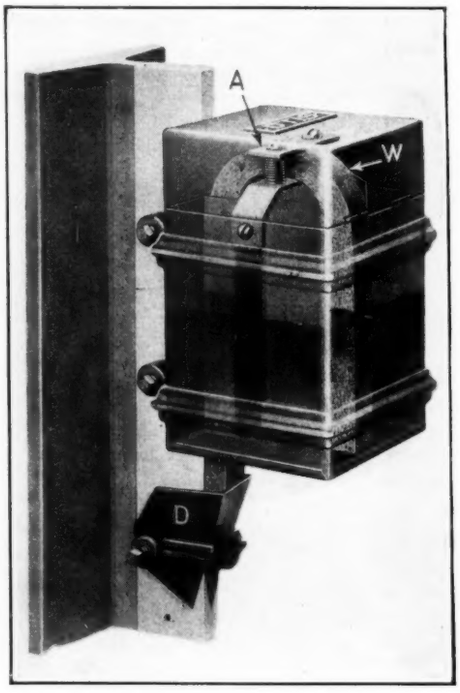


Fig. 1—Phantom view of lubricator mounted on the top end of guide rail

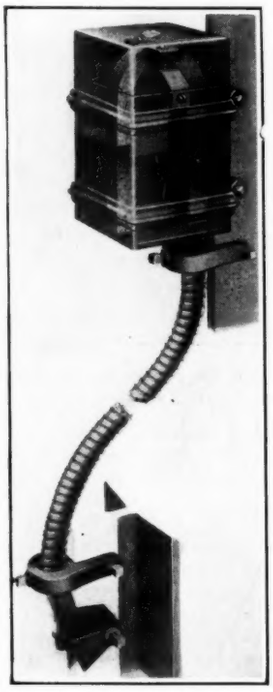


Fig. 2 — Lubricator mounted above the guide rail

Welding Power Plant Piping

By A. W. Moulder
Manager, Heating, Power and Industrial Piping Division, Grinnell Company, Inc.

THE results of tension tests on full-sized specimens of welded pipe joints are contained in this article, which is an abstract of the paper "Welding of Power Plant Piping," presented by the author at a joint meeting of the A.S.M.E. and the A.W.S.

IN DISCUSSING welding of power plant piping, only the oxyacetylene method will be considered. This is primarily for the reason that the process is the one that has been found most practical for work of this kind, probably owing to the fact that the welding of power plant piping is not a production problem, but one where every job presents a somewhat different "cut and fit" problem. The ability of the same operator to use the torch for both cutting and welding has no doubt had considerable bearing on the fact that this process has been most generally adopted for this class of piping work. Furthermore, our own research work and most of the research work with which the writer is familiar and which deals with the particular problems involved, has been in connection with the oxyacetylene process. It has been our experience, however, that where the electric-arc process has been employed by us, the same general methods of preparation of materials, training and testing of welders and testing of finished products have been employed, and as far as we have been able to determine without going into the same research work, with equally satisfactory practical results.

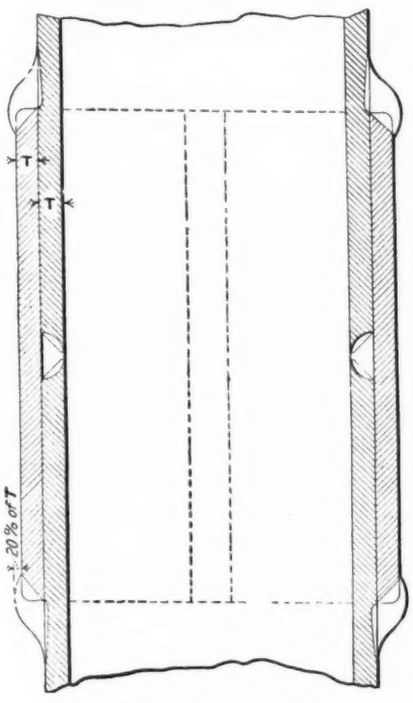


Fig. 1—Sleeve Weld

The welding of power plant piping is unquestionably growing in favor. There are a number of basic reasons behind this growth which, briefly, are as follows:

1. Elimination of screwed and flanged joints with resulting lower maintenance costs.
2. Lower first cost, especially where a multiplicity of connections are made to a pipe in a limited area, such as in the case of headers.
3. Decreased weights, especially where welded steel is substituted for large cast fittings.
4. Continuity of insulation is permitted by elimination of flanges, with resulting increased efficiency and decreased cost of insulation.
5. Improved service in erection, especially where field welding is employed and in overcoming the time required for the making up of "special" or odd-shaped fittings.

All of these advantages were, of course, recognized in the early days of pipe welding. The importance of power plant piping, however, in that a failure not only endangers the life and limb of employees, but cuts off a most important service, has had a just deterring effect upon the growth of welding for this class of work as compared to its growth in other classes of piping work. A number of the more responsible concerns dealing in the fabrication and erection of power plant piping have been furnishing piping of this class for many years, and the record in connection with these materials has been so excellent as to gradually win over the confidence of engineers and purchasers until today welded piping is growing in use.

Much has been said in a general way about the effect of locked-in stresses caused by uneven heating and cooling of the weld zone. About two years ago we set out to determine something about the effect of these internal stresses upon the over-all strength of the pipe joint. Strain gage tests were made in connection with both annealed and unannealed sections of 4-in. pipe by cutting out ¾-in. strips 3 in. long at four places around the pipe weld. The results were relatively unimportant except that they show the entire strains to be compression and they show further that there are relatively different strains in unannealed pipes. This method of testing was not carried forward to reach any definite conclusions.

It was known that coupons cut from welded pipe and with welds made by trained welders, when pulled would break outside the weld zone, but this did not answer that continually recurring question about the effect of internal stresses, because when the coupon is cut from the joint, the mechanical stresses are released. We, therefore, decided that the most practical test to determine this would be to pull the pipe with the welds in its entirety, or in other words, pull full section samples. This work was started more than a year ago with 4-in. pipes.

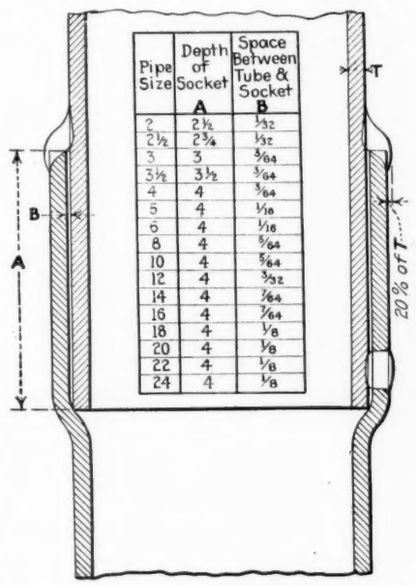


Fig. 2—Normal socket, and socket and pin type joint

After a number of tests of both annealed and unannealed sections it was decided that the 4-in. pipe did not represent the worst condition as to the internal stresses, and therefore the work was shifted to another laboratory capable of pulling larger pipes. The work thus started created considerable interest and was continued in the new laboratory on a much larger scale. Through the courtesy of the National

Tube Company an advance report of the results of a long series of tests along this line has been made available.

Figs. 1, 2 and 3 show various types of welds in common use for long lines of piping. Particular attention is called to Fig. 2, which illustrates two types of welds on which test results are reported. The left half of the figure shows a normal socket-type joint while the right half of the figure illustrates a normal socket joint with pins.

The Shape of the Fillet

One of the developments of the preliminary tests was the shape of the welded fillet. To approach perfection, the lines of force should be kept as nearly straight as possible. This means making the shape of the fillets gradually sloping without abrupt turns, otherwise under stress the sharp corners check, gradually throwing the stresses farther inward toward the pipe material. In Figs. 1, 2 and 3 will be seen what

RESULTS OF TESTS ON OXWELD JOINTS MADE ON ONE SIZE OF PIPE BUT WITH DIFFERENT TYPES OF JOINTS

Pieces Tested	Types of Joints	Broke Off in Welds Pcs.	Broke Off in Welds Loads in Tons	Broke Off in Pipe Pcs.	Broke Off in Pipe Loads in Tons
	Pipe 4 in. O.D. x .1875 in. Thick				
6	Normal sockets	..	.....	6	67.000
6	Socket & Pins	..	.....	6	67.833
6	Butted joints	..	.....	6	69.000
	Pipe 8 in. O.D. x .1860 in. Thick				
6	Normal sockets	..	.....	6	140.160
6	Socket & Pins	..	.....	6	140.160
6	Butted joints	1	147.000	5	131.800
	Pipe 12 in. O.D. x .2500 in. Thick				
6	Normal sockets	1	288.00	5	270.400
6	Socket & pin	1	262.00	5	252.000
6	Butted joints	1	280.00	5	283.400
	Pipe 16 in. O.D. x .3125 in. Thick				
6	Normal sockets	4	426.50	2	420.000
6	Socket & pins	6	377.83	..	.....
6	Butted joints	5	431.20	1	446.000
72		19		53	

is meant by the building up of fillets and the design of what might be called stream-line effects in them.

The table shows a summary of the test results on three types of welds. It

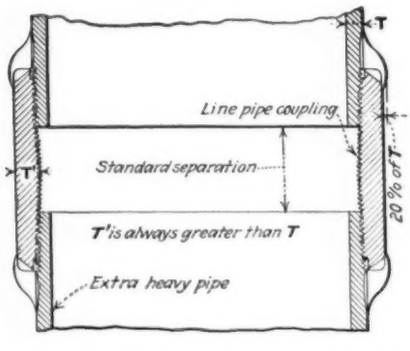


Fig. 3—Welded screw-coupling joint

will be noted that even those pieces that broke in the welds, held an average tensile load practically equal and in many cases in excess of the pieces which broke entirely outside of the weld zone. It might be added that no pieces in the entire test broke at a point that indicated low strength.

Fig. 4 shows two pieces of 16-in. pipe made with a regular butt weld. One of these, it will be noted, broke entirely outside of the weld zone and the other one directly in the weld. The piece marked 6,517, however, broke at 446 tons pull and piece 6,520 broke at 448 tons.

Fig. 5 shows a screw coupling back welded in 14-in. pipe as shown by Fig. 3. This shows one of the earlier tests and is included merely to bear out the fact that this type of pipe weld is strong and safe.

Beyond what details were learned from these tests they show that when properly designed for reinforcement and when made by properly trained welders, these joints in varying types can be made to overcome whatever internal stresses are locked in, as none of these joints were annealed.

The writer has had no cause to change his original ideas as to the efficiency of the plain butt weld as compared to mechanically reinforced types, and it will be interesting to note that the results show somewhat greater strength for this type of weld over

Fig. 4—Butt weld 16-in. pipe after test

others in the series of tests illustrated. It is the writer's belief that adding straps or reinforcements complicates the stresses. The only portions of this series of tests that in any way indicate this, are the relative tests of normal socket welds as compared with socket welds with pins, the latter usually fracturing around the pins before either the joint itself or the pipe was fractured. In other words, the addition of the pins apparently added nothing to the over-all strength of the joints and detracted something in that a leak was caused to appear around the pins under a tensile pull comparatively lower than the strength of the joint.

Behavior of Welds Under High Pressures and Temperatures

A question is often raised as to the behavior of welds under high pressures and temperatures. With increased steam pressures the piping materials are correspondingly increased in weights. The proper design of welds necessarily provides for a proportionate increase in the thickness of fillet and building up of the welds, so that the relative strength of the joint is maintained. Recently, there was an interesting preliminary report on the subject of "Welds at Elevated Temperatures," in which one of the conclusions reached after some very excellent research work was: "As far as ultimate strength is concerned, a strong weld cold is in general a strong weld hot." This conclusion would indicate that welded joints made to proper design are just as safe proportionately when used in connection with the high pressures and temperatures encountered in the modern power plants as they have

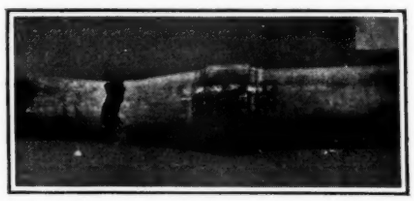


Fig. 5—Test on 14-in. pipe with welded screw-coupling joint

been found to be by years of trial and experience operating under the lower pressures.

Engineers responsible for the piping going into power plants realize that they are dealing with a problem where a single failure may be of tremendous import. Therefore, they can be commended only if at times they seem extremely rigid in their specifications and over careful as to the ability and integrity of the pipe fabricator.

When an Employer Is Liable for Acts of Employee

By Leo T. Parker

IN MANY instances damages have been effected as a result of negligence on the part of an employee in igniting property when smoking cigarettes, cigars or pipes. The rule is established that an employer is liable for damages thus effected to property of third persons, provided he knew or should have known that his employees were in the habit of smoking under the same or similar circumstances which resulted in the damage effected.

For illustration, in Palmer vs. Keene Forestry Association, 112 Atl. 798, an employer was held liable for damages caused a third person by a fire started by an employee carelessly dropping a lighted cigarette. This Court explained the law as follows:

"If the defendant (employer) knew, or ought to have known, they were in the habit of smoking cigarettes, he also must have known that habit, if practiced by them, might reasonably be expected to do serious damage to his property or to others."

It followed that the employer was chargeable with the knowledge of the damage likely to be effected. He ought to have instructed the men against the practice of the smoking habit under circumstances where it was liable to result in serious damage to third persons.

RECENT PUBLICATIONS

VOM LABORATORIUMSPRAKITUM ZUR PRAKTISCHEN WARMETECHNIK (From Laboratory Practice to Practical Heat Technic). By C. Blacher, Professor, University of Latvia, Riga. Published by Otto Spamer, Leipzig, Germany. 322 pages. Price, 18.5 Reichsmarks, ($4.50).

THIS volume is the tenth in the series of monographs on heating technic, published by this house. It deals with the theory and practice of calorimetry, efficiency of combustion, heat transfer, temperature, water treatment, corrosion, fuel gases, internal-combustion motors and kindred subjects. These topics are treated briefly, to suit the requirements of a textbook for use in the technical high school.

A DIRECTORY OF COMMERCIAL TESTING AND COLLEGE RESEARCH LABORATORIES has recently been issued by the United States Bureau of Standards. The directory is known as miscellaneous publication No. 90 and can be obtained for 15 cents a copy by writing to the Government Printing Office, Washington, D. C.

THIS volume represents an attempt on the part of the Department of Commerce to collect and publish a directory of the commercial testing and college laboratories in the United States. Laboratories of consulting chemists, engineers and metallurgists and research laboratories of manufacturing companies and other industrial research laboratories have been listed only in cases where definite information had been supplied that they were engaged in commodity acceptance testing on a commercial basis.

STEAM TURBINES. By Edwin F. Church, Jr. Published by McGraw-Hill Book Co., Inc., New York. Cloth; 6x9 in. 265 pages. Price, $3.

THIS treatise is intended to serve as a textbook for a short but thorough course in steam turbines and does not go into the more complex questions of turbine design. A working knowledge of thermodynamics, of the ordinary steam cycles, the ability to use steam tables, and a familiarity with the ordinary laws of mechanics, are assumed. The first chapter discusses the various types and contains a large number of cross-section drawings and photographs that illustrate the various types. The theory of steam flow and its practical application to flow through the nozzle and blade passages of a turbine are treated in the second and third chapters. In succeeding chapters are discussed turbine losses, efficiency, reheat, governing and design.

DAUERVERSUCHE ÜBER DIE ALTERUNG VON DAMPFTURBINEN-ÖLEN IM BETRIEB. Published by Vereinigung der Elektrizitätswerke, E.V., Berlin, 1927. 50 pages. Price, 8 Reichsmarks ($2).

THIS book gives the results of a joint research carried out on the effect of extended operation on steam turbine lubricating oils by the Vereinigung der Elektrizitätswerke, E.V., Berlin, and the Verein Deutscher Eisenhüttenleute, Düsseldorf. The work described in the publication was carried out by Dr. Baader, of Cologne, Dr. Baum, of Essen, and F. L. Hana, of Zschornewitz. These men co-ordinated the researches of three different groups and joined in writing this work, each of them writing that part covering the research carried out by him, and the three joining together in a summary of the results obtained. Tabular results of the experiments are given, and a supplement contains a large-sized chart giving curves for different types of oil used in three different makes of turbines, and for periods varying from a few hours up to 700 hours of operation.

Owing both to the different design of equipment used in the United States and the different lubricants commonly available, it is impossible to apply these German results directly to American practice. However, the experimental methods used by these German workers and the results obtained by them, might well serve as a guide for further work that may be done on the subject of altering of steam turbine lubricants in service in this country.

KOKEREI-UND GASWERKSÖFEN. By L. Litinsky. Vol. 17, of a series on coal, coke and tar, treating of practice in producing, refining and using fuels, edited by Dr. J. Gwosdz. Published by Wilhelm Knapp, Halle (Saale), 1928. 336 pages. Price, 21 Reichsmarks ($5).

THIS volume deals with coke ovens and gas retorts. After a brief historical account of the development of this apparatus, it gives clear and concise descriptions of the principal available types of this equipment. The final part of the book is taken up with a discussion of various methods of obtaining the byproducts from coal with ovens and retorts, the use of heat in coal distillation, and the heat balance of distillation equipment. One chapter is devoted to the subject of refractory materials for oven construction which, although it devotes considerable space to materials like chamotte, which are not used in the United States, still contains many interesting facts concerning construction materials for coke and gas plant use. The book is well illustrated with both photographs and drawings and contains much tabular matter of interest to engineers in the gas business.

While the fact that this volume is published in German will make it unavailable to many who could otherwise profit by its use, it contains much information from the German viewpoint on coal distillation equipment and processes, which should be useful to the American engineer. It would make a good addition to the library of any engineer who is sufficiently conversant with technical German to use it with some degree of confidence.

NATIONAL ELECTRICAL CODE—Purpose and development of the National Electrical Code and its relation to electrical manufacturers is outlined in some detail in a recent publication issued by National Electrical Manufacturers Association, 420 Lexington Ave., New York City. The booklet is designated as "The National Electrical Code, Its Purpose and Development." The code is a collection of rules and regulations governing choice and installation of electric wiring, materials, apparatus and supplies and the procedure for making changes in the Code, together with important data about Underwriters' Laboratories, addition of "New Materials" and "Field" changes in the Code are here outlined for the first time under one cover. The rapid growth in the use of electricity and the spread of radio has caused a flood of inquiries to the Association office, which officials of NEMA believe will be largely answered in this publication.

FORESTS AND FLOODS is the title of a 24-page booklet by Ward Shepard, Forest Inspector, Branch of Public Relation, Forest Service. This publication is known as Circular No. 19, of the United States Department of Agriculture, Washington, D. C. The pamphlet gives a simple presentation of the relation of forests and reforestation to floods. It also briefly describes forest conditions in the Mississippi basin. Reforestation and forest protection will probably enter into any comprehensive plan for the control of the Mississippi. The fact that engineering works are the main defense against floods should not be permitted to obscure the importance of well-kept forest and other vegetable cover for reducing run-off and soil evasion, is the opinion of the Forest Service, and this booklet is a study of these problems.

TRADE ASSOCIATION ACTIVITIES—A volume of 381 pages published by the Department of Commerce, prepared by Irving S. Paull, J. W. Millard and James S. Taylor, as No. 20 of Domestic Commerce Series, price 75 cents, lists and describes all important trade bodies in the United States. Chapter XXIV deals with engineering and other technical groups.

NEWS *of the* FIELD

Urges Rules to Guide Relations Between Government and Utilities in Power Development

Declares for Projects by Government Initiative Only When Primarily Entered Upon for Federal Purposes—Use of Water Sold at Full Value, and Co-operation with Producers

TO MEET the situation presented on the Colorado, St. Lawrence, Columbia and Tennessee Rivers, where development plans may originate with the government, a set of principles which should govern the relationship between the government and the utilities has been proposed by J. T. Newcomb, counsel for the Joint Committee of National Utility Associations.

"The time is rapidly approaching when the construction of important works involving the waters of the United States for flood control, stream regulation, navigation and kindred purposes is to be undertaken by the government." Mr. Newcomb said in part, in an address, March 5 before members of the Cosmos Club in Washington, "In the Federal water power act the legislation deals with situations where the initiative in bringing about development comes from the power companies.

Co-ordination Necessary

"In respect to the Colorado, the St. Lawrence, possibly the Columbia and the Tennessee the initiative may come from the government. The policy of adjustment between the government and the power companies under such a situation takes in certain new aspects not heretofore dealt with in legislation. It seems to me, therefore, especially important that correct principles of co-ordination and co-operation between the government and the utilities be worked out and enunciated in legislation which may prove to be the pioneer in the movement."

Three Principles Involved

As such principles to be recognized and employed where the initiative comes from the government, and where obviously a large part of the capital will be put in by the government, Mr. Newcomb proposes the three following rules:

"No such projects should be undertaken unless they are clearly and primarily entered upon in the fulfillment of federal government purposes. Although in performing such functions the government will frequently find itself necessarily involved, when water is stored for flood control or rivers regulated for navigation, it will incidentally happen that power can be produced and water supplied for domestic users, neither of which would be justifiable as the primary reason for undertaking the project. Under such circumstances power and water should be sold advantageously and cities accommodated in their domestic needs.

Should Sell at Full Value

"Assuming, then, that the project is primarily one for the carrying out of government purposes, and that there is an incidental opportunity to secure revenue from the sale of the right to use impounded waters, the second important principle is to secure the most advantageous terms for the government without unnecessarily disturbing economic conditions. This means that the right to use the water should be disposed of by the government at its fair value. It should not be sold for less than its value because neither power users nor anybody else should be made the special beneficiaries of government expenditures by getting water or power at less than its value.

Co-operative Plans Important

"In addition legislation should specifically promote co-operation with the existing power producers. The power companies make their plans reaching far into the future. By construction programs, both steam and hydro-electric, formulated, for example, in the present year, they are preparing to fill the demand for electric current perhaps in the year 1933. Where government projects are to be developed involving the production of power or the development of power opportunities, some way should be found by which the private projects and the government projects can be co-ordinated.

Policy Must Be Followed

"All this requires, of course, a clearly announced policy on the part of the government, firmly adhered to, which can be depended upon by the private companies."

Deep Water Plant to Operate at 1,350 Lb. Pressure

The Deep Water Station on the Delaware River, N. J., according to present plans, will be the first new plant designed entirely for 1,350 lb. boiler pressure.

Four standard and two reheat 1,350 lb. pressure boilers will be supplied by the Babcock & Wilcox Company, according to Stevens & Wood, Inc., New York City, who are under contract for the designing and construction of the plant.

Each of the four standard boilers, with its steam economizer and air preheater, will produce 331,000 lb. of steam per hour at 725 deg. F. The two reheat boilers will deliver 290,000 lb. of steam per hour and will reheat 419,000 lb. of steam to 775 deg. F.

Delivery in Summer, 1929

The initial capacity will be approximately 118,500 kw., and the ultimate about 400,000 kw. Two 53,000-kw. units, together with one 12,500-kw. pressure unit will be installed. This equipment is scheduled for delivery during May and June, 1929 and is the largest order of equipment designed to operate at this pressure which has ever been placed in this country.

The plant will supply the process steam to the adjacent plant of E. I. du Pont de Nemours & Company, Inc. It is owned jointly by the American Gas & Electric Company and The United Gas Improvement Company.

Wisconsin to Appoint Fellows in Engineering Research

Two research fellowships in engineering are to be appointed April 30 by the University of Wisconsin. Candidates must be graduates of engineering colleges of recognized standing, and, preferably, should have had one or two years of graduate study, of teaching, or of engineering experience.

The appointments will be for a period of two years, subject to satisfactory service, and the salary will be $900 for the first year and $1,100 for the second year. A fellow will be expected to devote not less than half time to assigned research in the College of Engineering, but will be given an opportunity to complete the requirements for a master's degree within the two-year period.

Applications will be received up to April 15. Information and application blanks can be obtained from Dean F. E. Turneaure, College of Engineering, Madison, Wisconsin.

Committee to Meet on Plans for World Engineering Conference

The American committee of the World Engineering Congress, appointed by Herbert Hoover, honorary chairman, will meet in Washington, March 22 to formulate plans for the participation of American engineers in the Congress, which will be held for the first time in Tokio in 1929.

Tsuneo Matsudaira, Imperial Japanese Ambassador to the United States, will be the host at a dinner in Washington on that date, to the members of the American Committee, according to an announcement by Maurice Holland, secretary.

The occasion, bringing the American committee together for the first time, is for the purpose of organizing a general committee into several subcommittees which will be directly in charge of program and papers, finance, transportation and other details connected with the participation of the American delegates to the congress.

Baron K. Furuichi, president of the Kogakkai, the engineering society of Japan which is fostering the congress, has invited governmental departments, universities, institutes, associations and individuals collaborating in engineering in the principal countries of the world to take part in this international session, which will be held in Tokio for two weeks toward the end of October, 1929.

A tentative program on which papers have been requested from the American and other committees includes general engineering problems and special studies in such fields as public works, railways, harbor and river engineering, communication and transportation, chemicals, textiles, mining and metallurgy and scitific management.

Artificial Lightning Sets New Record

Artificial lightning of 3,600,000 volts, the highest voltage yet obtained, and approximately seventeen times the highest voltage transmission line in this country, has been produced in the high-voltage engineering laboratory of the General Electric Company, at Pittsfield, Mass.

The achievement was announced by F. W. Peek, Jr., in charge of this work, March 7, in speaking before the regional meeting of the American Institute of Electrical Engineers in St. Louis.

Designed to produce lightning at millions of horsepower, this new generator is unique in its manner of operation. Electricity is gradually stored in artificial clouds, just as it is accumulated in real thunder clouds. It is then discharged in a blinding flash of but a few millionths of a second, producing all the effects of natural lightning, according to Mr. Peek.

"Lightning sparks, produced by these voltages lasting but one ten-millionth of a second, can be seen as a blinding flash. However, as light travels about 100 ft. in that time, the phenomenon is over when a person standing but 100 ft. distant sees it, or when the light reaches him. Yet," Mr. Peek explained, "it appears to be there."

A.S.M.E. Fuels Division Plans Second National Meeting

The second national meeting of the Fuels Division of the A.S.M.E. will be held during the week of Sept. 17 in Cleveland.

The program of this meeting is being planned in accordance with the policy of the Division to bring together all the latest information about the utilization of fuels. A comprehensive program lasting four days will be carried on with the support of the Cleveland Local Section.

A special committee has been appointed to conduct the meeting under the chairmanship of Col. Elliott H. Whitlock. The other members of this committee are P. V. Fraser, Theodore Maynz, John Wolff, F. H. Vose, and H. K. Kugel.

The technical program will be under the general guidance of the chairman of the Fuels Division, Victor J. Azbe, of St. Louis.

The first national meeting of the committee was held in St. Louis in October, 1927.

Governor Smith Agrees With Leaders on Two Power Bills

Governor Smith and Republican legislative leaders in New York agreed on two water-power bills March 5.

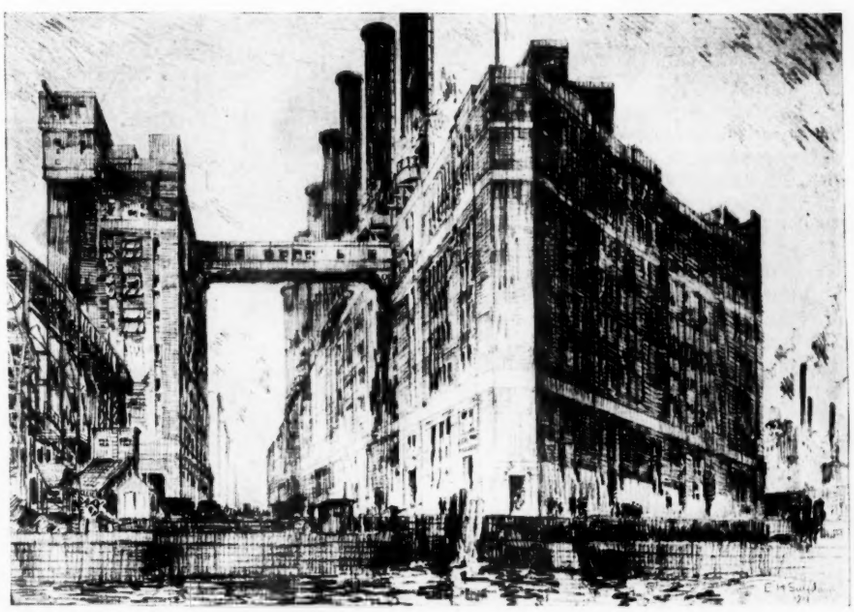
The Governor indicated that he would favor two bills introduced by Willis H. Sargeant, Republican, of Onondaga. One would prohibit any water-power developments in the Adirondacks at an altitude of more than 1,500 ft. and is designed to protect Saranac Lake, Lake Placid and other mountain villages from the danger of being wiped out through power developments.

The other would create a commission to investigate and determine the question of a fair return to the state for state land flooded in connection with power developments on inland streams.

The Governor said recently he had discussed the two bills with the Association for the Protection of the Adirondacks, and had at that time agreed to favor the measures.

District Heating Course at Purdue, May 21-26

A district heating school will be conducted at Purdue University, Lafayette, Ind., May 21-26. Prof. C. H. B. Hotchkiss, who will have charge of the course, has recently made an extensive tour of several Eastern cities during which he collected a large amount of material and many ideas from prominent members of the National District Heating Association, under whose auspices the course will be held.



An architect's drawing of the main building of the new East River Station of the New York Edison Company, as it will look when completed. The first section was placed in operation in November, 1926. It will have a total capacity of almost 1,250,000 kw. The station was designed by the firm of Thomas E. Murray, Inc., in consultation with the officers and engineers of the New York Edison Company

Wins Right for Quebec Project of 500,000 Hp.

After a warm verbal battle between opposing forces, the Private Bills Committee of the Quebec Legislature approved of the bill of the Beauharnois Light, Heat & Power Company, whereby the company is vested with authority to build a power canal between Lake St. Francis and Lake St. Louis, where 500,000 hp. of electrical energy will be developed within ten years.

Premier Taschereau, who strongly supported the measure, explained that the company was prepared to deposit $500,000 in cash with the provincial treasurer, in guarantee of the fulfillment of its contract to produce 500,000 hp. One stipulation in the contract is that there shall be no export of power to the United States either by direct or indirect means.

Strong Opposition Expressed

Appearing on behalf of the Montreal Light, Heat & Power Company, which opposed the passage of the bill, George H. Montgomery stated that the bill was a mere piece of camouflage. The original charter of the company provided for a small development, he said, whereas it was now proposed to construct works which were estimated to cost $250,000,000. Other opponents of the measure contended that it meant drying up the St. Lawrence River between Lake St. Francis and Lake St. Louis, thereby putting an end to the present power plants in the river, such as the Canadian Light, Heat & Power Company, and the Cedar Rapids development of the Montreal Light, Heat & Power Company.

Connected With St. Lawrence Waterway

Interest in the action of the Quebec Legislature in passing the bill, is manifest in federal government circles at Ottawa, because of the fact that the Beauharnois project is connected with the St. Lawrence waterway and also because, supplementary to any powers conferred at Quebec, the federal government must also give its sanction.

There is a possibility, however, that this sanction may not be given until the courts decide the question of federal and provincial jurisdiction in connection with water powers developed on navigable waterways.

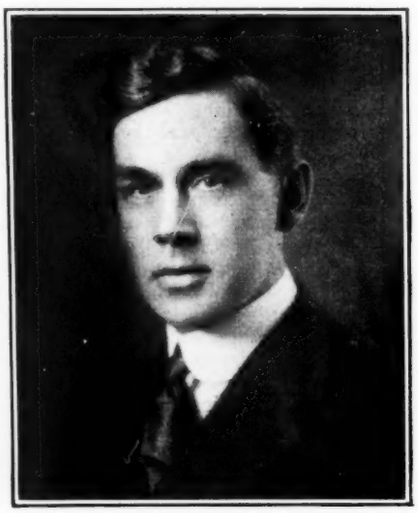
Buy Three Diesels for River Service

The Anticosti Corporation, Canada, has purchased a 700-hp. Fairbanks-Morse cold start Diesel engine for a tug new under construction by the Davie Shipbuilding & Repairing Company.

The Canadian International Paper Company recently purchased two 210-hp. six-cylinder Fairbanks-Morse Diesel engines for tugs, making a total of five now in use. The Diesel tugs "Pythonga" and "Chelsea" have been in service on the Gatineau River one season, and the "Templeton" has been in service two seasons on the Ottawa River.

Dr. Harvey N. Davis Is Selected Head of Stevens Institute

Dr. Harvey Nathaniel Davis, now occupying a chair of mechanical engineering at Harvard University, has been selected as president of Stevens Institute of Technology, Hoboken, N. J., to succeed the late Dr. Alexander C. Humphreys, who resigned last June upon the completion of 25 years of service. Doctor Davis will assume his new duties Sept. 1, Walter Kidde, acting chairman of the board of trustees, announced March 7.



Dr. Harvey N. Davis

Doctor Humphreys, who made his last public appearance at the Stevens commencement on June 21, 1927, died Aug. 14. Dr. Frank L. Sevenoak, a member of the Institute faculty, has since served as acting president. Doctor Davis has an outstanding reputation as economist and educator, as well as engineer. He has been professor of mechanical engineering at Harvard since 1919, and there previously served as instructor and assistant professor in physics.

Of Diverse Activities

Doctor Davis's professional activities, ouside of the educational field, include engineer in the turbine department of the General Electric Company, aeronautical mechanical engineer in the United States Air Service, consulting engineer in the United States Bureau of Mines and in the Franklin Railway Supply Company and the Air Reduction Company.

He was born in Providence, R. I., June 6, 1881, a son of the late Nathaniel French Davis, formerly head of the Department of Mathematics at Brown University, and of Lydia Martin (Bellows) Davis. He was graduated with distinction at Brown University, from which he received the degrees of A.B. and A.M. He then entered Harvard University, his work there leading to the degrees of A.M. and Ph.D. Subsequently he joined the Harvard faculty.

High Pressure Steam Authority

Doctor Davis is a fellow of the American Academy of Arts and Sciences and a member of the Washington Academy of Sciences, American Society of Mechanical Engineers, American Physical Society, American Mathematical Society, and of the Phi Beta Kappa, Sigma Xi and Delta Phi fraternities.

A leading authority on high-pressure steam, Doctor Davis is the author (with Prof. L. S. Marks) of "Steam Tables and Diagrams," and also (with Prof. N. Henry Black) of "Practical Physics for High Schools." He is also the author of various papers on thermodynamic subjects.

To Be Third President

"Although Stevens Institute was incorporated in 1870 and opened it doors in September, 1871, Doctor Davis will be only its third regular president, said Mr. Kidde. "His experience, qualifications and standing make him a worthy successor both to Doctor Humphreys and to the original president, Dr. Henry Morton."

Utah's Potential Water Power Extensive, Survey Finds

Unused water resources sufficient to sustain large development in water power and agriculture are available in the San Juan River Basin in southeastern Utah, according to a statement made public by the Department of the Interior March 6.

A report drawn up by E. C. LaRue, hydraulic engineer of the Geological Survey, who made an investigation of the basin, the statement said, shows that the undeveloped power resources consist of ten power sites capable of yielding, with storage, about 280,000 hp., in contrast to the 7,500 now being generated by four plants.

Circuit Breaker Ordered for United Electric Light

The United Electric Light & Power Company of New York, has contracted for eighteen 5,000-ampere type "0-44," three-phase, horizontally segregated phase oil circuit breakers, disconnecting switches and associated details.

These breakers have an interrupting capacity of 1,500,000 kva. at 15,000 volts. This switching equipment will be supplied by the Westinghouse Electric & Manufacturing Company.

To Install Generators

The International Nickel Company will install in the extension to the Spanish River plant three 8,000-kva. 6,600-volt 25 cycle, 187½-r.p.m. vertical-type generators, with direct-connected exciters and Kingsbury thrust bearings, having ordered these from the Canadian Westinghouse Company. The turbines are being supplied by the Dominion Engineering Company.

Recalling a Century Ago

OF MUCH interest as an engineering relic is the old Newcomen atmospheric pumping engine, shown in the accompanying illustration, and still to be seen at Fairbottom, near Ashton-under-Lyne, England, where a century ago it pumped water from the Cannel mine, 70 or 80 yards deep, assisted by a water wheel, long since removed.

Wagon Boiler Used

The steam side of the engine comprises a cylinder 26 in. or 28 in. in diameter, with a stroke of 6 ft. The beam as will be seen, is of wood braced with iron, and has segmental ends to which the piston rods and pumps are attached by chains. The steam was generated in a wagon boiler, now standing alongside, and the coal was brought from a pit some distance away.

It was reported that the piston was kept steamtight by pouring on top of it a solution of horse manure and water. Besides pumping water the engine was put to a further and much more humble use, namely, that of scaring birds from neighboring crops. With this object a cord tied to the elevated center of the beam communicated with a "ricker" in the fields. It is interesting as throwing a sidelight on the derivation of place names, to mention that the oscillating or "bobbing" moving of the beam caused the locality to be called "Fairbottom Bobs."

In the photograph the steam cylinder appears at the right, with the wagon boiler behind it. The segmental ends of the beam were obviously adopted to provide a straight line travel for the rods of the engine and pump. The use of the chain above the steam cylinder indicates conclusively that the engine was single acting, the piston doing its work on the down stroke, when the steam was condensed in the lower part of the cylinder.

Of Simplest Design

The strain on the beam must have been considerable, as it was heavily braced by the curved arm and iron work on the top side, in spite of which a bad crack appears at one point. Note the pivot in the center: evidently, nothing so elaborate as a bearing and journal was attempted.

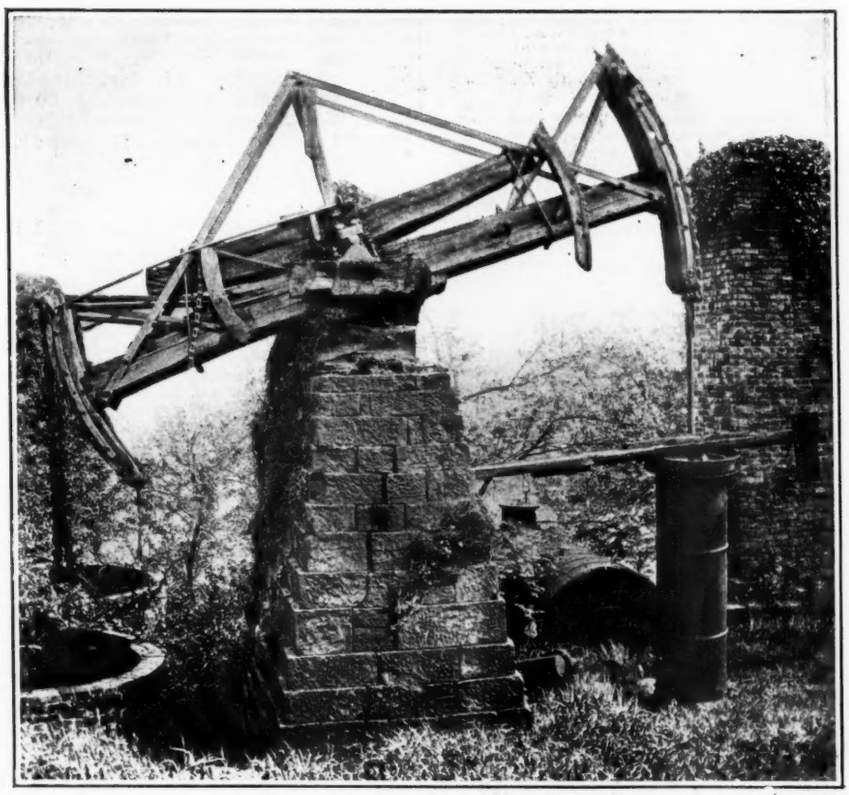


Photo obtained through the courtesy of Loughnan Pendred, editor of The Engineer

Obituary

George Urban, Jr., 77 years old, one of the early pioneers in the electrical development of the Niagara Frontier, died at his home, near Buffalo, Feb. 23. He was ill but three weeks. Many years ago, attracted by the practical possibilities of electricity, Mr. Urban journeyed to New York to interview Thomas A. Edison. The result of the interview was that Mr. Urban returned to Buffalo with a small electric generator, one of the first Edison built. This generator, now in the possession of the Buffalo General Electric Company, was the first electrical machine in Buffalo. Mr. Urban was vice-president and director of the Buffalo General Electric Company, president and director of the Niagara Electric Service Corporation and a director of the Buffalo, Niagara & Eastern Power Corporation.

Personal Mention

Gerald A. Albert, is now an instructor in electrical engineering at the Stevens Institute of Technology, Hoboken, N. J.

Charles E. Beardsley, president of Beardsley & Wolcott Manufacturing Company, has been elected president and a director of Bridgeport Brass Co., succeeding Carl F. Dietz.

J. E. Dawson, for nine years assistant engineer at the River Power Station of the Potomac Edison System and for nearly 42 years actively engaged in power plant operation, recently retired, an impromptu reception being arranged in his honor.

Prof. Henry Le Chatelier, eminent French chemist, was awarded an honorary membership in the American Society of Mechanical Engineers Feb. 28, when Charles M. Schwab at a luncheon in Paris presented him with a certificate of the society and a medal for his introduction of new methods of physico-chemical analysis.

H. D. Shute, vice-president of the Westinghouse Electric & Manufacturing Company, accompanied by Arthur Brown, assistant vice-president of the company, has been on a tour of the Pacific Northwest, visiting power plants and calling on electrical officials of prominence in the territory.

Carroll G. Bennett, chief engineer of the Illinois Commerce Commission, has resigned to become chief engineer for the Public Service Company of Northern Illinois, with offices in Chicago. Employees of the commission presented Mr. Bennett with a handsome gold watch as remembrance of their pleasant association.

CHARLES M. SCHWAB, chairman of the board of the Bethlehem Steel Corporation and past-president of American Society of Mechanical Engineers, will be awarded by the British Iron and Steel Institute the Bessemer Gold Medal, May 4. Mr. Schwab is president of the American Iron and Steel Institute, and also an honorary vice-president. Now in Europe, he will attend the meeting of the Institute, which will be held in London.

Society Affairs

AMERICAN WATER WORKS ASSOCIATION, Florida Section will hold its second annual meeting at the San Juan Hotel, Orlando, April 3-4; E. L. Filby, secretary, P. O. Box 135, Jacksonville Fla.

PLANT ENGINEERS CLUB, Boston, at the Boston City Club, informal dinner and meeting 7:30 o'clock, March 14; Martin Frisch, Combustion Engineering Corporation, will speak on "Combustion."

A.S.M.E.—Engineers' Club of San Francisco, March 29, 7 p.m. Subject: "The Design of Steam Electric Generating Stations," by R. C. Powell, assistant chief of division of electric distribution and steam, Pacific Gas & Electric Company, of San Francisco.

A.S.M.E.—Philadelphia — Engineers' Club of Philadelphia, 1317 Spruce St., Philadelphia, March 27; dinner at 6 p.m. Meeting at 8 p.m. Subjects: "Progress in the Burning of Coal," by Prof. A. G. Christie, professor of mechanical engineering, Johns Hopkins University, Baltimore, Md. Special and Anti-Knock Fuels," by Dr. Graham Edgar, director of research, Ethyl Gasoline Corporation, New York; "Recent Developments in Low Temperature Carbonization," by Col. H. D. Savage, president of the Dry Quenching Equipment Corporation, New York.

A.I.E.E., Boston Section, Tremont Temple, 7:30 p.m., following buffet supper; "Reminiscenses of Heaviside and Steinmetz: Their Personalities and Work," Dr. Ernest Julius Berg, Union College, Schenectady, N. Y.

I.E.S., New England Section, Engineers Club, Boston, 7:45 p.m., March 30; "Modern Methods of Design for Electrical Advertising," W. C. Brown, and "Electrical Advertising Activities," by E. B. Fox.

Coming Conventions

American Association of Engineers, annual convention, El Paso, Texas, June 4-6; M. E. McIver, secretary, 63 Adams St., Chicago.

American Institute of Electrical Engineers, Baltimore Regional Meeting, District No. 2. April 17-19; New Haven Regional Meeting, Northeastern District, No. 1, in May; Summer Convention, in Denver, June 25-29.

American Institute of Refrigeration, Washington, D. C., May 10-11.

American Refractories Institute, annual meeting at White Sulphur Springs, W. Va., May 8-9; Dorothy A. Texter, secretary, 2202 Oliver Bldg., Pittsburgh.

American Society of Refrigerating Engineers, meeting at Detroit, June 4-7; W. H. Ross, secretary, 37 West 39th St., New York City.

American Society of Heating and Ventilating Engineers, Summer meeting at West Baden Springs Hotel, West Baden, Ind., June 26-29; A. V. Hutchinson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers, spring meeting in Pittsburgh, May 14-17; Calvin Rice, secretary, 29 West 39th St., New York City; Twin-City regional meeting at St. Paul, Aug. 27-30; Boston regional meeting, Oct. 1-3.

American Society for Testing Materials, Atlantic City, June 25-29.

American Water Works Association. Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

Association of Iron and Steel Electrical Engineers, annual convention and Iron and Steel Exposition at Hotel Stevens, Chicago, June 25-29.

Indiana Fuel Conference at Purdue University, Lafayette, Ind., April 5-6.

National Association of Power Engineers, annual convention at Detroit, Sept. 11-15, and concurrently National Exhibitors' Assn. exhibit; Fred Raven, 417 South Dearborn St., Chicago.

National Board of Boiler and Pressure Vessel Inspectors, meeting at Erie, Pa., June 18-20.

National Electric Light Association, Convention and exhibition, Atlantic City, N. J., June 4-8; A. Jackson Marshall, secretary, 420 Lexington Ave., New York City.

National District Heating Association, annual meeting at Ambassador Hotel, Atlantic City, June 12-15; D. J. Gaskill, sec., 112 West 4th St., Greenville, Ohio.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Universal Craftsmen Council of Engineers, Newark, N. J., Aug. 7-10.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

Business Notes

SCHWEITZER & CONRAD, INC., Chicago, has appointed J. Leo Scanlon as the company's New York City correspondent effective March 1, according to announcement.

THE WORTHINGTON PUMP & MACHINERY CORPORATION, 115 Broadway, New York City, has announced that the company will move the main office from that address to 2 Park Avenue, April 1.

GIFFELS, HAMILTON & WEEBER, engineers, Kelsey Office Building, Grand Rapids, Mich., announce the above name as the new firm name to succeed the old one of Burd, Giffels & Hamilton, with offices at the same address.

THE LINCOLN ELECTRIC COMPANY announces the appointment of O. D. Fries as salesman in charge of consumer motor business in the Detroit territory under the direction of J. M. Robinson, district manager.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	
Navy Standard...	New York.....	$2.50@$2.65
Kanawha.....	Columbus.....	1.25@ 1.60
Smokeless.....	Cincinnati.....	2.00@ 2.25
Smokeless.....	Chicago.....	1.85@ 2.25
S. E. Kentucky...	Chicago.....	1.40@ 1.60
Steam.....	Pittsburgh.....	1.75@ 1.85
Gas Slack.....	Pittsburgh.....	1.00@ 1.25
Big Seam.....	Birmingham....	1.50@ 2.00
Anthracite (Gross Tons)		
Buckwheat.....	New York.....	$3.00@$3.25
Birdseye.....	New York.....	1.60

FUEL OIL

New York—Mar. 8, light oil tank-car lots, 28@34 deg., Baumé, 4½@5c. per gal.; 36@40 deg., 5½@6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Feb. 28, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.60 per bbl.; 26@28 deg., $1.65 per bbl.; 28@30 deg., $1.70 per bbl.; 30@32 deg., $1.75 per bbl.; 32@36 deg., gas oil, 4.36c. per gal.; 38@40 deg., 5.12½c. per gal.

Pittsburgh—Feb. 21, f.o.b. local refinery, 30@34 deg., fuel oil, 4½c. per gal.; 36@40 deg., 4¾c. per gal.

Philadelphia—Mar. 7, 26@30 deg., $2.00@$2.06 per bbl.; 13@19 deg., $1.26 @$1.32 per bbl.; 22 plus, $1.58@$1.64 per bbl.; 27@30 deg., $2.10@$2.16 per bbl.

Cincinnati—Mar. 6, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5½c. per gal.

Chicago—Mar. 3, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 85@90c. per bbl.; 26@30 deg., 90@95c. per bbl.; 30@32 deg., $1.10@$1.15 per bbl.

Boston—Mar. 5, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@ 32 deg., 5¾c. per gal.

Dallas—Mar. 3, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

The Electric Machinery Manufacturing Company, specializing in synchronous motors and vertical alternators, Minneapolis, announce the appointment of T. H. Hayes, 507 Tractional Terminal Building, Indianapolis, Ind., as sales representative in that territory.

WILLIAM B. UPDEGRAFF, member of the A.S.M.E. at a recent meeting of the board of directors, was elected vice-president in charge of sales of the Watson-Stillman Company, 75 West St., New York City. For the last fifteen years Mr. Updegraff has been engaged in various engineering and sales capacities with this company.

THE MAGNETIC MANUFACTURING COMPANY has appointed T. F. Scannell, formerly connected with the Chain Belt Co. of Milwaukee, as exclusive representative in the St. Louis territory on complete line of magnetic separation equipment, magnetic clutches for power transmission, etc. Mr. Scannell's office will be located at 502 Ambassador Building.

E. D. HILL of the Allis-Chalmers Manufacturing Company, will be located at 42 Church St., New Haven, Conn. This will enable the company to more effectively serve this community in connection with motors, pumps and Texrope drives. The sales will be under the direction of A. F. Rolf, manager of the Allis-Chalmers New York office at 50 Church Street.

THE ERIE CITY IRON WORKS, Erie, Pa., has established a direct sales office at 122 South Michigan Ave., Chicago, with Charles B. Acheson as district manager, J. R. LeVally as special engineer, and D. F. Lytle as sales representative. Another sub-office has been established in the Chicago district, with E. J. Clerget in charge, at 511 Traction Building, Indianapolis, Ind.

Trade Catalogs

LUBRICATION FOR ALL MACHINERY—The Dot Lubrication Division, Carr Fastener Company, 31 Ames St., Cambridge, Mass., in a well illustrated and conveniently arranged catalog treats of Dot lubrication as fundamentally an analysis and plan designed to determine the most efficient method of securing lubrication on any type of machinery, through a study of the lubrication requirements either by the builder or the user of machines, and the preparation of a program based upon the facts brought out by analysis. Dot standard and Mogul guns and nipples, elbows, reducing bushings, couplings, extensions, gun brackets, Dot Nozzle-Fil equipment, Dot-O-Matic pressure cups, and Dot tank equipment are illustrated, described and listed as to price.

INDUCTION MOTORS—The Allis-Chalmers Manufacturing Company has prepared a new bulletin, 1118-E, covering Types "AR" and "AYR" polyphase induction motors which are squirrel cage and slip ring type motors for general purposes. This bulletin describes both the sleeve and roller bearing types and in standard horizontal and vertical construction.

FREQUENCY RECORDER—The Esterline-Angus Company, Indianapolis, has issued an illustrated bulletin, No. 1227, on frequency recorders manufactured by the company. The scale of these instruments is 55-65 cycles, distributed practically uniformly across a chart $4\frac{1}{2}$ in. in width. The scale and record chart have ten main divisions, one large division for each cycle, and each main division is divided into four smaller divisions, of $\frac{1}{4}$ cycle a division. The instrument, therefore, can be easily read to within $\frac{1}{16}$ cycle.

NEW PLANT CONSTRUCTION

Calif., Hollister — National Ice & Cold Storage Co., Postal Telegraph Bldg., San Francisco, is having plans prepared for the construction of a cold storage plant. Private plans.

Calif., Los Angeles—Kasare Cohn Hospital, c/o Curlett & Beelman, Union Bank Bldg., Archts., is having plans prepared for a hospital on Fountain Ave. Estimated cost $1,250,000.

Calif., Los Angeles—R. C. Yinger, 6362 Hollywood Blvd., Archt., is preparing preliminary plans for a 12 story apartment building on Beacon St. Estimated cost $750,000. Owners' name withheld.

Calif., Madera—City plans an election to vote $13,000 bonds for waterworks improvements including drilling of well, pumping equipment, mains, etc.

Calif., Pasadena—Syndicate of Eastern Capitalists, is having preliminary plans prepared for a 10 story apartment and hotel building on Colorado St. Estimated cost $1,000,000. Marston & Maybury, 25 South Euclid Ave., are architects.

Calif., Redwood City—City, E. M. Kneese, Clk, will soon award contract for waterworks improvements including pumping plant, etc. at Millbrae Villa tract.

Calif., Riverside—Dept. of Public Utilities, R. L. Boulden, Supt., plans the construction of a steam generating plant, 5000 kw. hr. capacity.

Conn., New Haven—Koppers Co., Waterfront St., awarded contract for the construction of a by-products plant to Koppers Erection Co., Waterfront St Estimated cost $100,000.

Conn., New London—Connecticut Power Co., 33 Union St., is having plans prepared for the construction of a service building at Water and John Sts. Estimated cost $40,000. Private plans.

Ill., Chicago — W. S. Crosby, 6 North Michigan Ave., Archt., is receiving bids for a 5 story hospital including boilers, house and vacuum pumps, air compressors, 15 ton ice machine, two elevators, etc., at Ashland and Maypole Aves., for Womens' and Childrens' Hospital, Paulina and Adams Aves.

Ill., Chicago — Koenigsberg & Weisfeld, 155 North Clark St., Archts., are receiving bids for a 10 story apartment building, including central refrigeration plant, elevators, etc., at 440 Barry Ave., for S. Clifford & Co., 111 West Washington St. Estimated cost $530,000.

Ill., Chicago—T. R. Bishop & Son, 35 South Dearborn St., Archts., are receiving bids for a 13 story apartment building, including central refrigeration plant, elevators, etc., at 26 Elm St., for S. H. Newman, 310 South Michigan Ave. Estimated cost $1,000,000.

Ill., Chicago—Syndicate, c/o Reliance Co., 11 South La Salle St., Contr., awarded contract for a 22 story apartment building at 3260-3270 Sheridan Rd. Estimated cost $5,000,000. Refrigeration system, elevators, etc. will be installed.

Ind., New Castle—Bellanca Aircraft Corp. of America, Inc., 349 Richmond Tr., Port Richmond, N. Y., will soon award contract for the construction of a 135 x 190 ft. factory, including power plant, etc., here. Estimated cost $100,000.

Ia., Emmetsburg—City to vote March 21 on granting franchise for construction and operation of municipal electric light and power plant. Estimated cost $148,000.

La., Pineville — Town, M. J. Rembert, Mayor, will receive bids until Mar. 20 for the construction of a sewage disposal plant, including main pumping station and booster pumping station, etc. Swanson-McGraw, Inc., Balter Bldg., New Orleans, is consulting engineer.

La., Shreveport — Shreveport Eldroado Pipe Line Co., awarded contract for a cracking still unit, boiler house, etc., to M. W. Kellogg Co., 7 Dey St., New York, N. Y. Estimated cost $175,000.

Mass., Boston—Hospital Dept., J. P. Manning, Pres. Bd. of Trustees, Harrison Ave., will reecive bids until Mar. 21 for alterations to power house on Albany St.

Mass., Cambridge (Boston P. O.)—J. J. Shine, 1400 Massachusetts Ave., awarded contract for a 6 story apartment building at Cambridge and Prospect St. to Chase & Gilbert, 250 Stuart St., Boston. Estimated cost $500,000.

Mass., Pittsfield—General Electric Co., C. C. Chesney, Gen. Mgr., had plans prepared for a new molding insulation mixing plant on Silver Lake. Estimated cost $40,000. J. Trainor, c/o owner, is architect.

Mich., Bay City—Chevrolet Motor Car Co., Flint, is having plans prepared for a 225 x 900 ft. factory at North Madison St., here. Estimated cost $450,000. Wright & Nice, South Saginaw St., Flint, are architects.

Mich., Detroit—Karp Bros. Coal & Ice Co., 3900 Orleans St., awarded contract for the construction of an ice plant on Gratiot Ave. to Zacks & Lerner, 407 Broadway Exchange Bldg. Estimated cost $100,000.

Mich., East Lansing—City will soon award contract for the construction of a pump house etc. in connection with sewage treatment plant.

Mich., Flint—W. G. Carnegie, 6 North Clark St., Chicago, Ill., archt., will soon receive bids for a 12 story hotel including elevators at 416 Stevens St. for Syndicate, c/o architect. Estimated cost $500,000.

Mich., Highland Park (Detroit P. O.)—Chrysler Motor Car Corp., 341 Massachusetts Ave., awarded contract for the construction of an 80 x 580 ft. body receiving and storing building to A. W. Kutsche, 2111 Woodward Ave., Detroit.

Minn., Minneapolis — Northern State Power Co., R. P. Pack, V. Pres. and Gen. Mgr., 15 South 5th St., will build a 12 story office building at 21-23 Fifth St. S., also a 5 story addition to present building at 15 South 5th St., both including steam heating system, etc. Private plans.

Minn., Rochester—Bd. of Education, S. L. Seaman, Clk., voted $130,000 bonds for the construction of a heating plant for high school. Ellerbe & Co., 692 Endicott Bldg., St. Paul, are engineers.

Miss., Clarksdale—Yazoo-Mississippi Delta Levee Board, awarded contract for the construction of a pumping station including 50,000 g.p.m. motor driven pumping equipment, etc., to Fairbanks, Morse & Co., 1000 St. Charles St., New Orleans, La. Estimated cost $36,000.

Mo., Hannibal—City will soon receive bids for municipal light plant improvements including a 500 kva. turbo-generator unit with condenser and auxiliary equipment, etc. Estimated total cost $150,000. The Arnold Engineering Co., 565 West Washington Blvd., Chicago, Ill., is engineer.

Mo., Marshall—City plans an election Mar. 14 to vote $80,000 bonds for the construction of a municipal light plant. Henrici-Lowry Engineering Co., 402 Security Bldg., Kansas City, Mo., is engineer.

Mo., St. Louis—Great Atlantic & Pacific Tea Co., 3127 South Grand Blvd., awarded contract for a bakery and warehouse to The Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $700,000.

Mo., St. Louis—International Life Insurance Co., 8th and Chestnut Sts., is having preliminary plans prepared for an office building including steam heating etc. Estimated cost $1,000,000.

Mo., St. Louis—D. D. Israel, 1720 Chestnut St., is having preliminary plans prepared for a 16 story hotel at 15th and Market Sts. Estimated cost $3,000,000. W. H. Gruen, 1510 Chestnut St., is architect.

Mo., St. Louis—Syndicate, c/o P. J. Bradshaw, International Life Bldg., Archt., is having preliminary plans prepared for a 23 story hotel including steam heating system, etc. at Ninth and Washington Ave. Estimated cost $850,000.

N. J., Newark—Newark District Church Society, 280 Prospect St., East Orange, is having sketches made for a 25 story office building including steam heating system, etc. at 981 Broad St. Estimated cost $3,500,000. Starrett & Van Vleck, 353 7th Ave., New York, N. Y., are architects.

N. Y., Brooklyn—Clark-Henry Corp., W. Gutman, Pres., 119 West 40th St., New York, had plans prepared for a 24 story hotel at Hicks and Pineapple Sts. here. Estimated cost $2,000,000. E. Roth, 1440 Broadway, New York, is architect.

N. Y., Brooklyn—Italian Memorial Hospital Assn., Room 612, 191 Joralemon St., plans the construction of a hospital at Prospect Ave. and 8th and 9th Aves. Estimated cost $1,000,000. Architect not selected.

N. Y., Jackson Heights—Cosmopolitan Enterprise Inc., plans the construction of two 6 story apartment buildings at Pettit Pl. and Layton St. Estimated cost $2,000,000. B. H. Whinston, 6 East 46th St., New York, is architect.

N. Y., New York—Corp., c/o I. Judis, 52 Vanderbilt Ave., awarded contract for a 16 story factory and loft building at 235 East 45th St. to J. H. Taylor Construction Co., 31 Union Sq. Estimated cost $1,000,000. E. Roth, 1440 Broadway, is architect.

N. Y., New York—Carnegie Hill Building Co. Inc., F. Willetts, Pres., 114 East 32nd St., had plans prepared for a 12 story apartment building at 1211 Madison Ave. Estimated cost $600,000. G. F. Pelham, 570 7th Ave., is architect. Work will be done by separate contracts.

N. Y., New York—Creston Apartment Corp., J. Perlbinder, Pres., 332 East 149th St., had plans prepared for 6 story apartment building at 175th St. and Topping Ave. Estimated cost $500,000. Franklin Bates & Heindsmann, 2526 Webster Ave., are architects.

N. Y., New York—Henry Fuldner & Sons Inc., 40 East 14th St., is having preliminary plans prepared for a factory, office and stores building. Estimated cost $500,000. Architect not selected.

N. Y., New York—A. C. & H. M. Hall Realty Co., 200 West 72nd St., had plans prepared for a 15 story hotel at 320 Riverside Dr. Estimated cost $1,200,000. L. F. Knust, 369 Lexington Ave, is architect.

N. Y., New York—Max Kurzrok Realty Associates Inc., 550 7th Ave., had plans prepared for a 22 story hotel at 145 West 51st St. Estimated cost $2,000,000. Schwartz & Gross, 347 5th Ave., are architects.

N. Y., New York—New York Edison Co., 130 East 15th St., had plans prepared for the construction of a sub-station at Laconia Ave. and Gun Hill Rd. Estimated cost $100,000. Thomas E. Murray, Inc., 55 Duane St., is engineer.

N. Y., New York—Nucomb Building Corp., 462 7th Ave., will build a 6 story apartment building at 204th St. and Broadway. Estimated cost $500,000. Bates, Heindemann & Franklin, 2526 Webster Ave., are architects. Work will be done by separate contracts.

N. Y., New York—One Hundred Fifteen East 61st Street Corp., W. S. Faddis, Pres., 101 Park Ave. awarded contract for a 15 story office building to Cauldwell-Wingate Co., 101 Park Ave. Estimated cost $900,000.

N. Y., New York—Ratner & Handes Construction Co., M. Bardes, Pres., 1005 Walton Ave., will build a 6 story apartment and stores building at 115 Nagle Ave. Estimated cost $600,000. L. Stillman, 1993 Jerome Ave., is architcet. Work will be done by separate contracts.

N. Y., New York—Six Hundred Seventeen 5th Ave. Corp., M. Muller, Treas., 17 East 42nd St., had plans prepared for a 40 story hotel at 54 East 59th St. Estimated cost $5,000,000. L. A. Abramson, 46 West 46th St., Archt.

N. Y., New York—Thirty-One West Fifty-Second Street Corp., S. Ogus, Pres., 2 Park Ave., had plans prepared for a 14 story hotel at 25 West 52nd St. Estimated cost $725,000. Buchman & Kahn, 2 Park Ave., are architects.

O., Cleveland—The Otis Steel Co., Jennings Rd., had plans prepared for an open hearth furnace building at 601 Clark Ave. Estimated cost $500,000. Private plans.

Okla., Oklahoma City—Artic Ice Co.; is having preliminary plans prepared for a 50 ton addition to raw water ice plant on Grand St. Estimated cost $100,000.

Okla., Rush Springs—City plans an election Mar. 16 to vote $30,000 for waterworks improvements including deep well pump and motor, etc. Estimated cost $30,000. J. C. Milliken, Chickasha, is engineer.

Pa., Pittsburgh—Alleghney County Steam Heating Co., 435 6th Ave., awarded contract for the construction of a central heating plant on 12th St., to H. M. Byllesby Co., 231 Clark St., Chicago, Ill. Estimated cost $2,000,000.

Pa., Pittsburgh—Mercantile & Theatre Properties Inc., 13th and Chestnut St., Philadelphia, plans the construction 8 story stores and theatre building at Penn Ave. and Euclid St. Estimated cost $2,000,000. Hoffman & Henon Co., Finance Bldg., Philadelphia, is architect.

Pa., Pittsburgh—U. S. Engineers Office, War Dept., Washington, D. C., will receive bids until Mar. 28 for the construction of a hydro-electric plant Lock 6 on Allegheny River here.

Tex., Alamo Heights—Bd. of Education, R. Steves, Jr., Elizabeth Rd., San Antonio, plans the installation of heating plant for entire group of four units of school buildings. H. P. Smith, National Bank of Commerce Bldg., San Antonio, is engineer.

Tex., Big Lake—City awarded contract for waterworks improvements including well, reservoir, pumps, etc. to Vedder Construction Co., Miami, Tex. Estimated cost $35,000.

Tex., Big Spring—Southern Ice & Utilities Co., c/o C. P. Couch, V. Pres., Dallas, plans the construction of a 100-ton ice plant here. Estimated cost $200,000.

Tex., Dallas—Brinkerhoff & Bennett Investment Co., American Exchange Bank Bldg., is having plans prepared for an 8 story medical building on Jefferson St. Estimated cost $750,000. Flint & Broad, Melba Bldg., are architects. Engineer not selected.

Tex., Dallas—W. D. Garlington, 2701 Fairmount St., will soon receive bids for an 11 story hotel at Live Oak. Architect not announced.

Tex., Kingsland—Syndicate Power Co., Dallas, subsidiary of Insull Interests, 72 West Adams St., Chicago, Ill., plans the construction of a series of hydro-electric plants and power dams on the Colorado River. Initial expenditure for 1928 $1,000,000. Total estimated cost $25,000,000.

Tex., Marshall—Marshall Milk Products Co., awarded contract for the construction of a milk plant including cold storage plant to J. Pressler. Estimated cost $30,000.

Tex., Maurita—J. Hatcher & C. W. McMillan, Edinburg, plans the construction of a cotton gin plant including power unit, probably electrically driven near here. Private plans.

Tex., Snyder—City is having plans prepared for a 20 to 25 ton ice plant. Estimated cost $40,000.

Tex., Vernon—City plans an election Mar. 20 to vote $60,000 bonds for waterworks improvements including pumping equipment, etc. Estimated cost $60,000.

Ont., Midland—Aberdeen Elevator Co., Tiffen St., is having plans prepared for changing present steam power plant to an electric system, etc. Estimated cost $150,000. J. S. Metcalfe & Co., Ltd., 434 St. Francis Xavier St., Montreal, Que., are engineers.

Ont., Toronto—Lake Semcoe Ice Co., 102 Dupont St., is having plans prepared for an addition to ice plant. Estimated cost $100,000.

Ont., Windsor—Canadian Pacific Railway, H. O. Montreal, is having plans prepared for the construction of a coal handling plant. Estimated cost $200,000. J. C. Irvine, c/o owner, is engineer.

Equipment Wanted

Boilers, Etc.—Canadian Salt Co., G. Duck, Gen. Mgr. Sandwich, Ont., plans to purchase boilers and chlorine manufacturing equipment for boiler house and chlorine plant recently destroyed by fire.

Boilers, Turbine, Etc.—Central Power & Light Co., Frost Bldg., San Antonio, Tex., plans the installation of two 725 hp. high pressure boilers and one 9000 hp. turbine for proposed extensions and improvements to power plant at Victoria, Tex. Estimated cost $250,000.

Conveyors—Chrysler Motor Car Corp., 341 Massachusetts Ave., Highland Park, Mich., plans to purchase conveyors, etc., for proposed plant

Engine—Municipal Utilities Co., Des Moines, Ia., plans to purchase a 480 hp. Diesel engine, etc., for proposed light plant at Emmetsburg, Ia. Estimated cost $148,000.

Engines, Generators, Oil Burners, Etc.—Western States Public Utilities Co., 521 Terminal Bldg., Lincoln, Neb., plans to purchase two 500 hp. Diesel engines, generators, oil burners, etc. for proposed power plant at Sheldon, Ia. Estimated cost $250,000.

Ice Making and Refrigerating Equipment—U. S. Veterans Bureau, F. T. Hines, Dir., Washington, D. C., will receive bids until Apr. 3 for ice and refrigeration equipment for U. S. Veterans Hospital, at Fargo, N. D.

Motor—J. J. Mayfield, Raymondville, Tex., plans the installation of a 100 hp. electric motor in proposed cotton gin plant, estimated cost $18,000.

Motor—Musick Plating Works, 915 Chestnut St., St. Louis, Mo., plans to purchase a 15 or 20 hp. motor, d.c., 200 or 500 v., 900 r.p.m.

Pump and Motor—Utilities Comn., Utilities Bldg., London, Ont., prices and catalogs on a 4 m.g.p.m. water pump direct connected to a 500 kva. synchronous motor for proposed waterworks improvements.

Pumping Equipment—Bd. of Trustees, Aurora Sanitary District, Room 2-6, 22 River St., Aurora, Ill., will receive bids until Apr. 5, for pumping equipment for proposed sewage disposal plant.

Pumping Equipment—A. C. Seid, Clk, Carlisle, Ia., will receive bids until Mar. 20 for pumping equipment, etc. for proposed waterworks improvements. Estimated cost $27,000.

Pumping Unit—City of Midland, Tex., plans to purchase a pumping unit, etc. for proposed waterworks system. Estimated cost $130,000.

Puming Units, etc.—Dept. of Water, W. W. Morehouse, Dir., Room 308, V. B. Annex, 15 East 4th St., Dayton, O., will receive bids until Apr. 2 for furnishing and installing electric motor driven centrifugal sewage pumping units, etc.

Pumps—Bd. of Water Comrs., T. W. Drought, Ch., Broadalbin, N. Y., will receive bids until Mar. 16 for pumps, etc. for proposed waterworks.

Pumps, etc.—J. Q. Kirby, Clk., City Hall, Bowling Green, Ky., will receive bids until Mar. 27 for motor driven pumps, filter equipment, etc., for proposed water filtration and softening plant.

Pumps, Etc.—Town of Blind River, Ont., plans to purchase pumps, etc. for proposed waterworks improvements. Estimated cost $150,000.

Pumps, Blowers, etc.—Dept. of Public Service, J. M. Stewart, Dir., Kenmore, O., will receive bids until Apr. 2 for pumps, blowers, etc., for proposed sewage treatment plant.

Refrigeration Equipment—W. H. Dumart, Palmerston, Ont., plans to purchase refrigeration equipment, etc., for recently acquired packing plant, estimated cost $50,000.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

IMPORTANT declines occurred during the month in prices of power-plant and electrical supplies. Armored cable, No. 14 solid, is down $1 per M. ft. on two conductor and $2 on the three conductor. Discounts on lead-covered cable are up 2 to 10 points, indicating price decline. Flexible cord prices are off about 55c. per M. ft. in 250-ft. coils. The reduction in rubber-covered copper wire amounts to about 25c. per M. ft., compared with February levels. A decline, averaging 2½c. per lb., affected babbitt metal in all grades except anti-friction metal for general service. Linseed oil is lower by 2c. per 7½-lb. gal. at Cleveland. The principal advance of the month was that of 10c. per 100 lb. in cold-drawn steel at New York warehouses. Boiler rivets and wiping cloths are also higher.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 68c. per ft.
Common, 2½-in., cotton-rubber lined	80c. per ft. list, less	50%

Air—Best grade

¾-in., per ft.	3-ply	$0.36½	4 ply	$0.44

Steam—Discounts from List

First grade	30-10%	Second grade	40%	Third grade 45%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	45%	Second grade	50%

LEATHER BELTING—List price, 24c., per lin.ft. per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium	35%
Heavy	30%

RAWHIDE LACING—For cut, best grade, 30-10%; 2nd grade, 50-10%. For laces in sides, best, 46c. per sq.ft.; 2nd, 42c. Semi-tanned, cut, 30-10%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ¾ in.	$0.95
Asbestos for high-pressure steam, ¼ in.	1.75
Duck and rubber for piston packing	.95
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.30
Rubber sheet	.50
Rubber sheet, wire insertion	.80
Rubber sheet, duck insertion	.60
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.25@2.35 per bbl. without bags, in carload lots, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00@20.00
Colored	9.00@13.00	12.00	12.00@17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.15
New York	.17@.17½
Cleveland (*per thousand*)	38.00

LINSEED OIL—These prices are per 7½-lb. gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.76½	$0.84	$0.78

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	13.75

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, small, including ⅞-in. dia., list (Apr. 1, 1927) less 50-10% in full keg lots, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, per 100 lb.:
New York..... $5.00* Chicago... $3.60 Pittsburgh mill.....$2.75

Cone-head boiler rivets, per 100 lb.:
New York..... $5.00* Chicago... $3.60 Pittsburgh mill..$3.10@3.25

*Price is for full keg lots; broken keg lots, $6.50 net.

REFRACTORIES—Prices in car-load lots, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	per net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	per net ton	26@29
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, Soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	per net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	69.00
Commercial genuine, intermediate grade	57.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	12.00

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.60
Flat or square	3.90	4.15	4.10

BOILER FITTINGS—F. o. b. New York or Jersey City, discounts from list:

	Current
Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are net prices per 100 ft. at New York warehouses on tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17.07
1¼	.....	.....	19.20
1½	.....	$38.00	17.92
1¾	.....	28.50	20.48
2	$17.33	25.00	20.24
2¼	19.84	28.25	23.00
2½	21.60	34.00	26.03
3	25.50	42.50	27.04
3½	30.25	49.50	30.67
3½	31.50	52.75	33.33
4	38.03	67.00	40.11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.
These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.
In addition to the above, standard cutting charges are as follows:
2 in. and smaller.. 5c. per cut. 3 in..... 9c. per cut.
2¼ and 2½ in..... 6c. per cut. 3½ to 4 in.... 10c. per cut.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent. 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$29.00 (net)	$44.00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	30%
Coils to 1,000 ft	60%	35%
1,000 to 5,000 ft	65%	38%
5,000 ft. and over	67%	40%

CONDUIT—Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
⅜	72.07	78.63	10.21	11.63	6.46	7.03
½	103.31	113.00	15.10	17.21	8.39	9.13
¾	139.77	152.88	20.51	23.07	11.78	12.75
1	167.12	182.79	27.34	30.76	14.56	15.75
1¼	224.85	245.94	50.13	56.40	19.41	21.01
1½	355.50	388.85	82.03	92.28	27.73	30.01
2	464.88	508.50	218.74	246.10	41.59	45.01
2½	585.30	637.74	483.04	543.46	55.46	60.02
3	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$17.20
No. 16 cotton reinforced heavy		21.00
No. 18 cotton reinforced light		13.20
No. 16 cotton reinforced light		17.60
No. 18 cotton Canvasite cord		14.60
No. 16 cotton Canvasite cord		16.90
No. 16 super service cord or similar (2 wire) in 1,000 ft	$72.00	*80.00
No. 14 super service cord or similar (2 wire) in 1,000 ft	110.00	*122.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100 amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard Package, 64%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than standard package	22%
Standard package	40%
Discount Without Contract—Renewals:	
Less than standard package	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less than standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.50
0-30 ampere, less than standard package	2.80

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard A type bulbs:

100—130 Volt Watts	Type	Price Each	200—260 Volt Watts	Type	Price Each
15	A 17	$0.23	Special		
General			25	A 19	$0.28
25	A 19	.23	50	A 21	.28
40	A 21	.23	100	A 23	.50
50	A 21	.25			
60	A 21	.25			
100	A 23	.40			

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$5.75	$9.10	$10.69	$17.00
12	9.20	12.20	13.80	23.25
10	12.85	15.80	17.90	30.15
8	18.75	21.65	23.20	41.40
6	.....	.....	33.00	.....
4	.....	.....	46.30	.....
2	.....	.....	64.00	.....
1	.....	.....	89.35	.....
0	.....	.....	110.00	.....
00	.....	.....	129.00	.....
000	.....	.....	157.00	.....
0000	.....	.....	185.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package	$0.11	$0.11	$0.18	$0.16½	$0.15	$0.22
Unbroken carton	.14	.13	.20	.18	.16	.23
Broken carton	.16	.15	.22	.20	.18	.25

WIRING SUPPLIES—

Friction tape, ¾ in., less than 100 lb., 31c. per lb.	100 lb. lots.... 29c. per lb.
Rubber tape, ¾ in., less than 100 lb., 33c. per lb.	100 lb. lots.... 31c. per lb.
Wire solder, less than 100 lb., 33c. per lb.	100 lb. lots.... 31c. per lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25.00 to $50.00 list value	30-5%
$50.00 list value or over	35%